A STUDY ON TAXONOMICAL STATUS AND ECOLOGICAL DISTRIBUTION OF ZINGIBERACEAE IN MIZORAM

A THESIS
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IN
ENVIRONMENTAL SCIENCE

BY

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Certificate

*This is to certify that a Ph. D thesis entitled, "**A study on taxonomical status and ecological distribution of Zingiberaceae in Mizoram"** submitted by Mr. Lalnuntluanga Vanchhawng, Research Scholar in the Department of Environmental Science, Mizoram University Aizawl, embodied the record of original investigation under my supervision. I further certified that the thesis and the outcome of the research work is the first of its kind ever carried out in Mizoram. The content of the thesis and the part or parts thereof have not been borrowed from any other thesis nor does it submitted for the award of any degree in this or any other University or Institute.*

He is allowed to submit the Thesis for examination for the Award of the Degree of Doctor of Philosophy in Environmental Science.

Dated Aizawl,
the 6th April 2015

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Declaration

I, Lalnuntluanga Vanchhawng, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or to do the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other University/Institution.

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(LALNUNTLUANGA VANCHHAWNG)

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LIST OF ABBREVIATIONS USED

Amer.	-	American
Asiat.	-	Asiatic
Benth.	-	Bentham
Bih.	-	Bihar
Bot.	-	Botany, botanical, botanisk
Brit.	-	British
Buch. Ham.	-	Buchanan-Hamilton
Buitenz.	-	Buitenzorg
Bull.	-	Bulletin
c., ca.	-	confer: compare circa, circiter: about.
cf.	-	*confer* : Compare
Cab.	-	Cabinet
Christm.	-	Christmann
Cost.	-	Costaceae
Cyclop.	-	Cycloprint
Defin.	-	Definition
Dist.	-	District
E.	-	East, eastern
Econ.	-	Economic
Ed; ed(s)	-	Edition; Editor(s) or edited
Edin.	-	Edinburg
e.g.	-	*exempli gratia* : for example
EN	-	Endangered
Engl.	-	Englar
et al.	-	et alii; and others
Ethn.	-	Ethno
Exot.	-	Exotic
ex-situ	-	in an artificial condition
f.	-	*fide* : according to
Fisch.	-	Fischer
Fl.	-	*floret* : Flower
For.	-	Forestry

Fr	-	*fructus* : fruit
Gagnep.	-	Gagnepain
Gard.	-	Garden
Gen.	-	General, generum
Holt.	-	Holttum
Hook.	-	Hooker
i.e.	-	*id est* : that is
Ind.	-	India
Inst.	-	Institute
IUCN	-	International Union for Conservation of Nature and Natural resources
J.	-	Journal
Jahrb.	-	Jahrbucher
Jard.	-	Jardin
Koen.	-	Koenig
Kuntz.	-	Kuntze
Lalram.	-	Lalramnghinglova, H
L, Linn.	-	Linnaeus, Linnean
Lodd.	-	Loddiges
Lond.	-	Londinensis
M, m	-	*metrum* : metre
Mag.	-	Magazine
Malay.	-	Malaysia
Mant.	-	Mantissa
Med.	-	Medicinal
Monandr.	-	Monandrian
MZU	-	Mizoram University
N.P.	-	National Park
Nat.	-	*Natürlichen*
No.	-	*numero* : number
Nord.	-	Nordic
Obs.	-	Observationes
Or.	-	Orissa
Ord.	-	Ordines

p., pp.	-	*pagina* : page, pages
Parad.	-	Paradisus
Penin.	-	Peninsula
Pflan.	-	*Pflanzenfamilien*
Photo	-	Photographs
Pl.	-	Plant, plantarum
Prael.	-	Praelectiones
Pres.	-	Presidency
Rar.	-	Rariores
Rec.	-	Record(s)
repr.	-	Reprint
Res.	-	Research
Retz.	-	Retzius
Rev.	-	Revisio
Ridl.	-	Ridley
Rosc.	-	Roscoe
Roxb.	-	Roxburg
Roy.	-	Royal
S.	-	South
S.E.	-	South East
Salisb.	-	Salisbury
Sc.	-	Science
Schult.	-	Schultes
Schum.	-	Schumann.
Scit.	-	Scitamineae
Sing.	-	Singapore
Škorničk.	-	Škorničkova
Sm.	-	Smith
Soc.	-	Society, societe
Sp; spp.	-	species (singular); species (plural)
Spec.	-	Specimen.
Surv.	-	Survey
t.	-	tabula
Tax.	-	Taxonomy

Tidsskr.	-	Tidsskrift
Trans.	-	Transactions
Valet.	-	Valeton
Var.	-	*Varietas* : variety
Vice-versa	-	inversely
viz.	-	*videlicet* : namely
vol(s)	-	*volume* : volume; volumes
Wall.	-	Wallich
Willd.	-	Willdenow
W.S.	-	Wildlife Sanctuary
Zingib.	-	Zingiberaceae

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LIST OF PHOTOPLATES

VII	A - C	:	*Etlingera linguiformis*
	D - F	:	*Globba clarkei*
	G - J	:	*Globba multiflora*
	K - M	:	*Globba orixensis*
VII	A - B	:	*Globba schomburgkii*
	C - D	:	*Globba wardii*
	E - F	:	*Hedychium coccineum*
	G - H	:	*Hedychium rubrum*
	I - J	:	*Hedychium coronarium*
	K - L	:	*Hedychium ellipticum*
	M - N	:	*Hedychium flavescens*
	O - P	:	*Hedychium spicatum*
IX	A - B	:	*Hedychium stenopetalum*
	C	:	*Hedychium thyrsiforme*
	D - E	:	*Hedychium villosum*
	F - H	:	*Hedychium wardii*
	I - J	:	*Hedychium villosum var. tenuiflorum*
	K - M	:	*Hedychium yunnanense*
X	A - C	:	*Kaempferia pulchra*
	D - F	:	*Kaempferia rotunda*
	G - J	:	*Mantisia spathulata*
XI	A - B	:	*Mantisia wengeri*
	C - D	:	*Rhynchanthus longiflorus*
	E - G	:	*Zingiber ligulatum*
	H - J	:	*Zingiber rubens*
	K - L	:	*Zingiber officinale*
	M	:	*Zingiber purpureum*

Chapter 1

INTRODUCTION

1.1 Introduction

Zingiberaceae are perennial rhizomatous herbs growing in shady habitats and are characterized by the possession of a tuberous and creeping rhizome with an aerial shoot (pseudostem) often covered by sheathing leaf bases. Species of the Zingiberaceae are the ground plants of the tropical forests. They mostly grow in damp and humid shady places. They are also found infrequently in secondary forest. Some species can fully expose to the sun, and grow on high elevation. The ginger family, Zingiberaceae, is the largest family in Zingiberales with 53 genera and over 1200 species (Kress *et al.,* 2002). This family is widely distributed throughout the tropical and subtropical areas (Larsen *et al*., 1999). Zingiberaceae is generally regarded as one of the most highly resolved, natural and rather distinct of monocotyledonous families.

The systematic position of the family Zingiberaceae is as follows:

Kingdom	:	Plantae
Sub-kingdom	:	Phanerogamae
Division	:	Spermatophyta
Sub-Division	:	Angiospermae
Class	:	Monocotyledonae
Series	:	Epigynae
Order	:	Scitaminales
Family	:	Zingiberaceae

Zingiberaceae are pantropical, perennial terrestrial, rarely epiphytic, aromatic rhizomatous herbs, generally with simple unbranched stems. The leaves are entire, linear

lanceolate or oblong. They are either petiolate or sessile sheathing the stem. The flowers, terminating either leafy or leafless shoots, are borne in bractiate, cone-like spikes, heads or panicles, each bract subtending one or more flowers. The irregular flowers vary considerably among genera. The calyx is either tubular or bract-like, three parted or not. The corolla is tubular and three parted. It contains one stamen and one to four staminodes, the latter fused to form a lip or labellum. The stigma usually protrudes beyond the anther. The ovary is inferior, one to three celled topped by two nectaries, and contains many ovules, the stigma is funnel-shaped. The fruit is thick or fleshy capsule containing many seeds. Flowering occurs during the summer and early fall.

In the earlier classifications made by Petersen (1889) and Schumann (1904), the family Costaceae was included in the Zingiberaceae, but with a number of distinctive characters (e.g., lack of aromatic oils, branched aerial stems, and spiral monostichous phyllotaxy; (Specht *et al*., 2001) it is now accepted as the sister clade to the gingers (Kress, 1990, 1995; Kress *et al.*, 2001). The family is still poorly known taxonomically with many species (Theilade and Mood, 1997; Sakai and Nagamasu, 1998; Poulsen *et al.*, 1999; Williams *et al.*, 2002) and even genera (Newman, 1995; Mood & Larsen, 1997; Larsen & Mood, 1998; Sakai & Nagamasu, 2000; Kress & Larsen, 2001; Larsen & Jenjittikul, 2001) newly described in the last several years. Classification of Zingiberaceae based on vegetative and floral characteristics according to Holtum's (1950) comprises three tribes such as Hedychieae, Alpinieae and Globbeae are accepted by several researchers (Burtt & Smith, 1972; Larsen *et al.*, 1998). This classification is as illustrated in **Fig. 1.1.**

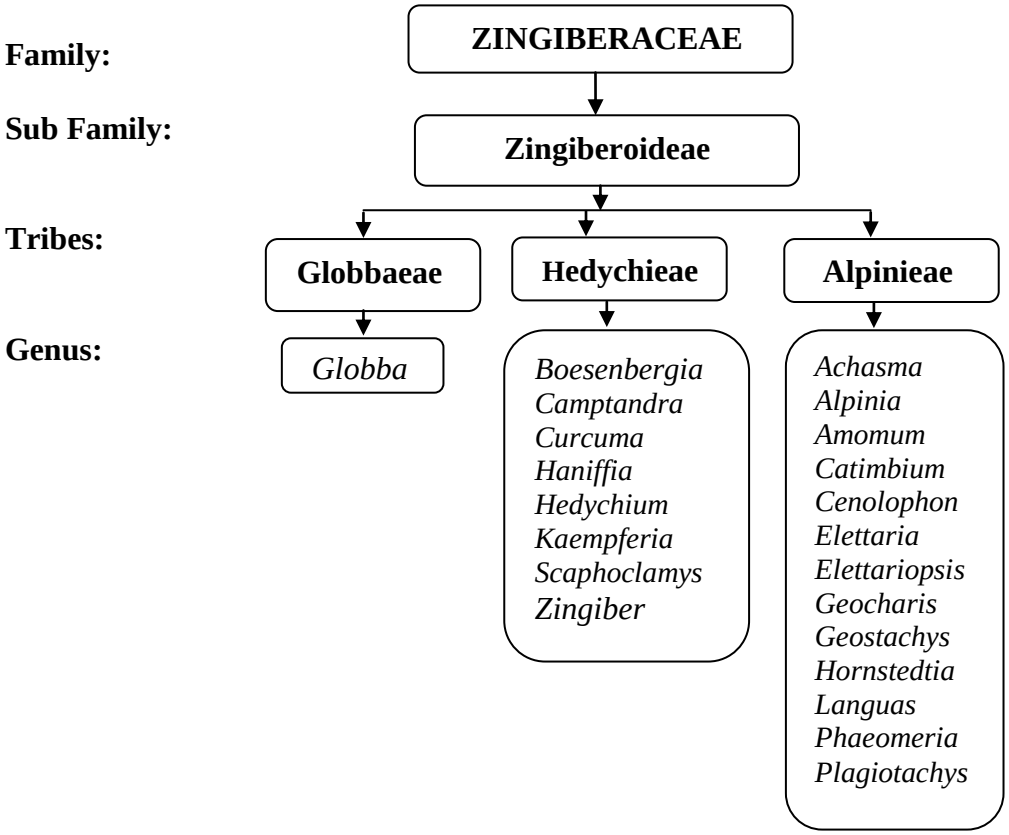


Fig. 1.1: Classification of Zingiberaceae according to Holtum (1950).

Recently molecular analyses have been used to study the phylogenetic relationships among the genera of the Zingiberaceae. The results of these molecular data analyses propose a new classification of the Zingiberaceae that recognize four subfamilies and four tribes (Kress *et al*., 2002). Tribes of the new classification of the Zingiberaceae are shown in **fig. 1.2**.

Zingiberaceae is one of the dominant families of understorey plants in tropical rain forests in Southeast Asia. Some species of Zingiberaceae have long been verbally reported as indicators of forest conditions whether disturbed or undisturbed, but they have never been formally and quantitatively studied. Nishimura and Suzuki (2000) examined the spatial distribution of several ginger species in relation to edaphic conditions in a tropical sub-

montane forest in Indonesia. They discovered that spatial segregation among ginger species, probably caused by interspecific differences in suitable edaphic conditions such as mesic-xeric conditions, is important for the maintenance of species diversity. This kind of ecological studies elucidate the species maintenance of ginger.

The family Zingiberaceae is generally considered as a spice family since they include many spices such as cardamom, turmeric, ginger etc. Commercially, the family is of great importance, since its members find use in medicinal, perfumery, flavour and cosmetic industries. Quite a large number of plants are used as ornamentals too. They are also well known for food, traditional, cultural and ritual.

In ancient time, turmeric (*Curcuma longa)* has been widely used in many purposes. Turmeric with several other species of the genus *Curcuma* grow wild in the forests of Southern Asia including India, Indonesia, Indo-China, nearby Asian Countries and some Pacific Islands including Hawaii. All of these areas have traditional culinary and medicinal uses going back to pre-history.

This family is readily differentiated from other families in the order Zingiberales by their aromatic property and is the most diverse in terms of utilization (Sabu, 2006). Some genera yield essential oils used in the perfume industry (*Alpinia galang.*, *Hedychium sp.*). Ornamental genera include the Shell gingers *(Alpinia zerumbet),* Summer tulip *(Curcuma alismatifolia),* Ginger lily *(Hedychium gardnerianum),* and Torch-ginger *(Etlingera elatior).* Spices include ginger *(Zingiber officinalis),* Galangal or Thai ginger *(Alpinia galanga),* Melegueta pepper *(Aframomum melegueta),* Myoga *(Zingiber mioga),* Turmeric *(Curcuma longa),* Cardamom *(Elettaria cardamomum).* It is important natural resource that provides many useful products for food, spices, medicines, dyes, perfume and aesthetics to man.

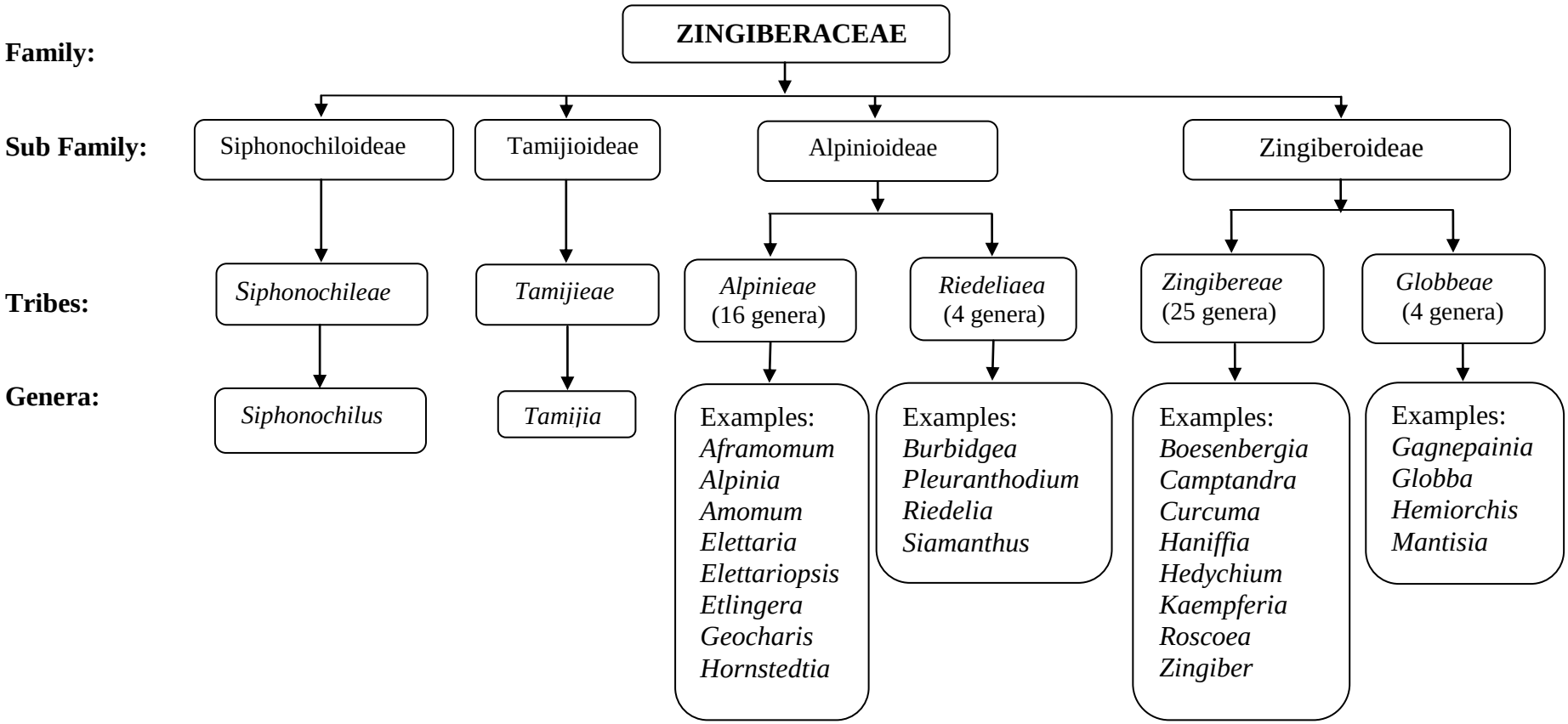


Fig. 1.2: Classification of Zingiberaceae based on molecular data (Kress *et al*., 2002).

1.2. Origin and history of Zingiberaceae

Zingiberaceae is believed to be originated from Southeast Asia and is now cultivated in most tropical countries. Its citations in ancient texts go back to the 4th century. The members are distributed mainly in tropics and sub-tropics with the centre of distribution in the Indo-Malayan region (Indonesia, Malaysia, Singapore, Brunei, the Philippines and Papua New Guinea), but extending through tropical Africa to Central and South America.

The Latin term *Zingiber* was derived from the ancient Tamil root, *ingiver*, meaning ginger rhizome. The term *ingiver* spread to ancient Greece and Rome through the Arab traders, and from there to Western Europe (Ravindran & Babu, 2005). The present day names for ginger in most of the Western languages were derived from this. Examples are *ingefaer* (Danish), *Gember* (Dutch), ginger (English), *Zingibro* (Esperanto), *harilik ingver* (Estonian), *inkivaari* (Finnish), *gingerbre* (French), and *ingver* (German). Some authors earlier thought that the term *Zingiber* was derived from the Sanskrit term *singavera* (Watt, 1872; Rosengarten, 1969; Purseglove *et al.*, 1981) meaning antler-like or horn-shaped, indicating the shape of the rhizome. It is improbable because the Sanskrit language was not popular in the region in those days. Ginger was exported from the ancient Malabar Coast on the southwest coast of peninsular India, and the Arab traders might have used only the prevalent local Tamil name for trading the commodity. Mahindru (1982) was of the opinion that the original word for ginger was in all probability a pre-Dravidian one and that it is found with minor variations in about 20 languages extending from China and the islands of the Pacific Ocean to England.

As far as documented evidence is concerned, turmeric is used daily in India for at least 6000 years as a medicine, beauty aid, cooking spice, and a dye. Ostensibly, it was used to worship the Sun during the solar period of India, a time when Lord Rama Chandra walked

the Earth. Especially in South India, people used to wear a dried turmeric rhizome bead the size of a large grape around their neck or arm. This is an ancient talisman tradition used to ward off evil and grant to the wearer healing and protection. Buddhist monks have used turmeric as a dye for their robes for at least 2000 years (Jager, 2003).

In the Indian Ayurvedic system of herbal medicine, turmeric is known as strengthening and warming to the whole body. Traditional uses in India include improve digestion, intestinal flora, to eliminate worms, to relieve gas, to cleanse and strengthen the liver and gall bladder. It is also used as blood purifier and also as anti-bacterial and anti-fungus.

The earliest mention of ginger cultivation is probably by Rabbi Benjamin Tudella, who travelled between 1159 and 1173 A.D. and gave an account of spices grown on the west coast of India (Ravindran & Babu, 2005). Tudella gives a vivid description of the place and trade in spices as well as cultivation of spices in and around the ancient port of Quilon in the State of Kerala (Mahindru, 1982). Marco Polo (A.D. 1298), in his famous travelogue, writes: "Good ginger also grows here and is known by the name of Quilon ginger. Pepper also grows in abundance throughout the country" (translation by Menon, 1929).

Fluckiger and Hanbury (1879) mentioned that, as early as the second century A.D. in Rome, ginger was one among the very few items on which duty was levied at Alexandria, the port of entry. In subsequent periods, including the Middle Ages, ginger was on the list of privileged goods in the European trade and duty was levied for its trade. In England it must have been well known even prior to the Norman Conquest, for it is frequently named in the Anglo-Saxon beech-books of the eleventh century as well as in the Welsh "Physician of Myddvai" (Parry, 1969). During the thirteenth and fourteenth centuries, next to pepper, ginger was the commonest and most precious of spices, costing nearly seven scrolling per

pound, or about the price of a sheep. The ancient Hawaiians used Zingiberaceae for many things, including the prevention and treatment of sinus infections, ear infections and gastrointestinal ulcers. Turmeric is eaten as a food both raw and cooked throughout Asia. Traditional use includes mashing/grinding it in a mortar to make a paste to mix with other spices for flavoring in curries.

Through combining fossil records with present distribution, the origin and the formation of recent distributional patterns of this family were probed. Fossil Zingiberaceae has been recorded in Europe and North America as well as in India, in late Cretaceous and early Tertiary. The family was probably common to very early Laurasia and West Gondwanaland (Raven & Axelrod, 1974). After the tertiary, the climate of Europe and North America became cooler, the Zingiberaceae gradually disappeared, but in Southeast Asia, it was less influenced by periods of glaciations, zingiberaceae continuously developed and became the centre of present distribution and species diversity (Wu Te-lin, 1985).

The present day distribution of taxonomic divisions of the Zingiberaceae, together with knowledge of plate tectonics, provides information that allows a tentative phylogeny of the family. The Zingiberaceae are still rapidly evolving in response to recent mountain uplifts: *Riedelia* and *Tapeinochilos* in New Guinea; *Caulokaempferia*, *Siliquamomum*, and *Boesenbergia* in southeast Asia; as well as *Costus* subgenus *Ornithophyllus* in the Americas are examples (Wood *et al.*, 2000).

The tribe Alpineae is the most primitive groups in the family which had their origin before South America and Africa had separated 70 million years ago. Presently *Alpinia*, the type genus of the tribe Alpinieae is found in tropical regions around the world *i.e.* South East Asia, Australia and Pacific Island (Larsen *et al.*, 1998; Smith 1990).

The genus *Amomum* is the second largest genus and comes under the family Zingiberaceae (formerly known as Scitamineae) with about 150 species (Thomas *et al.*, 2009). Large cardamom (*Amomum subulatum* Roxb.) is a large perennial spice crop cultivated in the swampy places in north-eastern and the central Himalayan region of India. In India, it was used as early as the 6th century BC in Ayurvedic preparations, as mentioned by Susrata (Sharma *et al.,* 2000). It has been given the name large cardamom, as it is being cultivated in a larger extent and also due to its position in the trade. It has been a well known spice since ancient time and has been valued for its pleasant aromatic odour due to which it is extensively used for flavouring vegetables and many food preparations in India.

The earliest reference to *Elettaria* (Cardamom) is a clay tablet from the ancient city of Nippur, Sumaria, dated 2000 BC (Weiss, 2002). Cardamons are reportedly described in the *Ayurvedic* literature in India (3rd Century BC), where they were recommended for stomach and urinary disorders. It was an article of trade between India and Greece during the 4th century BC. Cardamon is indigenous to India, Pakistan, Burma and Sri Lanka (Nadkarni, 1976). Guatemala is the largest producer of Cardamon followed by India.

The genus *Boesenbergia* contains around 80 species of tropical ginger relatives that are native to China, India, and Southeast Asia. *Boesenbergia* is used for ornamental, medicinal culinary purpose. *Boesenbergia longiflora* (Rosy Orchid Ginger) is originated from India.

Cautleya is a sister group to *Roscoea* and the two genera are monophyletic. It is a native of cool forests in the high altitude sub tropical and temperate areas of the eastern Himalayas.

The genus *Curcuma* is believed to be originated in the Indo-Malayan region (Purseglove, 1968; Harlan, 1975), and is widely distributed in the tropics of Asia to Africa

and Australia (Sasikumar 2005). Considering the great diversity of the genus represented by over 80 species in Indo-Malayan region, it is legitimate to consider that the genus originated in this region. The fact that over 40 species indigenous to this country, is supportive to its Indian origin. Turmeric *(Curcuma longa)* is a plant that has a very long history of medicinal use, dating back nearly 4000 years. In Southeast Asia, turmeric is used not only as a principal spice but also as a component in religious ceremonies. Because of its brilliant yellow color, turmeric is also known as "Indian saffron" (Prasad & Aggarwal, 2011). Further, based on the report of the unique species such as *C. vamana* having stoloniferous sessile fingers adds to the cause of its Indian origin (Valeton, 1918). The spices are considered to be the storehouse of active phytochemicals. The various spices belonging to the genus Curcuma are well known for their multiple uses as medicines, cosmetics, dyes, flavourings and neutraceuticals.

The genus *Globba* represents more than 100 species making it the third largest genus of the family Zingiberaceae behind *Alpinia* and *Amomum* (Kress *et al.*, 2002). It is primarily distributed throughout tropical and parts of subtropical Asia, ranging from India to Southern China, South and East Phillipines and New Guinea, with the centre of distribution in monsoonal Southeast Asia, especially Thailand and Myanmar (Williams *et al.*, 2004; Larsen, 1996; Kress *et al.*, 2003). In India, the genus is represented by 21 species and 1 variety with a (Baker, 1890; Rao & Verma, 1972; Singh & Kumar, 2011; Sabu, 2006; Somadeva, 1981; Srivastava, 1998; Thongam *et al.*, 2011).

Wood (1991) has studied biogeography and evolution of *Kaempferia galanga*. He believed that the genus, *Kaempferia* is supposed to have been originated in East Asia, most probably in Burma. It is widely distributed in Asia, Africa and Australia. It is grown in India, Myanmar, China, Nigeria, Mexico and other neighbouring countries. In India it is cultivated mainly in Kerala, Karnataka, Tamil Nadu and West Bengal. The history of use of *Kaempferia*

is established from various Asian cultures. It is cultivated in India, China, Malaysia, Indonesia, and Singapore. It is widely used as a flavoring in food, as well as a health aid. The rhizomes of *Kaempferiae galanga* have been used to aid in abdominal pain, swelling, and rheumatism (Othman *et al.*, 2002).

The genus *Caulokaempferia* K. Larsen comprises about 25 species, from humid environments: mossy rocks along streams, wet rock walls and swampy areas. It was established by the first author (Larsen, 1964) and further species were described by Larsen & Smith (1972) and Larsen (1973). Caulokaempferia has now been recorded from the Himalayas through south China, Indochina, Bangladesh, Myanmar, Vietnam, Laos and Thailand, with its centre of diversity in Thailand.

The genus *Hedychium*, (established in 1783 by J.G. Koenig) is an economically important genus, consisting of 65 species worldwide of which Northeast India has the highest species concentration (24 out of 65) (Wood *et al.*, 2000). Up to now, over 50 species, distributed mainly from eastern Himalayas to South India, South China and Southeast Asia are recognized. The medicinal efficacies of the essential oil extracted from leaves, flowers and rhizomes of these plants including cercaricidal properties (Warren & Peters, 1968), molluscicidal activity (Saleh *et al.*, 1982), antimicrobial activities (Gopanraj *et al.*, 2005), and anti-inflammatory and analgesic effects (Shrotriya *et al.*, 2007) are well established.

Recently several papers have used molecular data to explore the phylogenetic relationships within the family Zingiberaceae (Searle & Hedderson, 2000; Wood *et al.*, 2000) as well as within several genera (*Hedychium*: Wood *et al.*, 2000; *Alpinia*: Rangsiruji *et al.*, 2000; *Roscoea*: Ngamriabsakul *et al.*, 2000; *Aframomum*: Harris *et al.*, 2000). These analyses have succeeded in clarifying the patterns of evolutionary relationships to varying degrees, but in general have been limited in breadth of taxon sampling as well as resolution.

1.3. World's distribution

The Zingiberaceae is a pantropic family with 53 genera and over 1200 species. Zingiberaceae is the largest family of the order Zingiberales and it is widely distributed in the tropics in tropical and subtropical areas. The center of distribution is in Indo-Malayan region, but extending through tropical Africa to Central and South America (Kress *et al*., 2002). The greatest concentration of genera and species is in the Malesian region (Indonesia, Malaysia, Singapore, Brunei, Philippines and Papua New Guinea) (Sirigusa, 1997). Schuman (1904) recognised the Zingiberaceae as having 38 genera and 800 species, whereas Bailey (1949) recognised only 40 genera and 400 species, and 50 genera and about 1000 species by Dahlgren *et al.* (1985) and Willis (1948) recorded about 45 genera and 800 species. The number of valid genera as accepted today is 53 with about 1200 species (Kress *et al*., 2002).

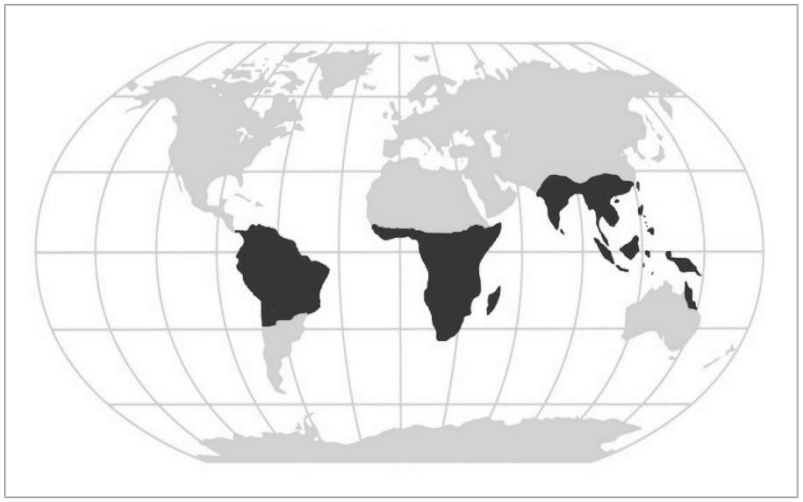


Fig. 1.3: Distribution of the pantropic family of Zingiberaceae

The Zingiberaceae is distributed pantropically with one genus *(Renealmia)* found in the Neotropics, four genera *(Aframomum, Aulotandra, Siphonochilus, and Renealmia)* found in Africa, and the rest of the genera distributed in east Asia and the Pacific Islands (Kress *et al*., 2002).

In West and Central Africa plants of the Zingiberaceae family are widespread in humid forest regions. They are distributed among eight genera, five of which are indigenous or endemic (*Aulotandra, Costus, Kampferia, Reneilmia* and *Aframomum*). The genus *Aframomum* is represented in West and Central Africa by approximately 50 species. The three others (*Pheaeomeri, Zingiber* and *Curcuma*) have been introduced. (Tane *et.al.*,2006). The diversity of *Aframomum* species is centred on Central Africa with several new species described recently (Dhetchuvi 1993, 1995, Dhetchuvi & Fischer 2006). Species of *Renealmia* exist in Africa as well as in the Americas.

1.4. Asia and South East Asia distribution

Southeast Asia is the evolutionary centre of the Zingiberaceae. The greatest concentration of genera and species is in the Malesian region (Indonesia, Malaysia, Singapore, Brunei, Philippines and Papua New Guinea) (Sirirugsa, 1997**)**. Monsoon region of Indo-china, including Thailand, also harbours the greatest biodiversity in the family (**Fig. 1.4).**

1.4.1. Thailand

Thailand is one of the richest countries for Zingiberaceae in the world. At least 300 species in 26 genera in 4 tribes Riedelieae, Alpinieae, Zingibereae and Globbeae of Zingiberaceae are found throughout Thailand, however, the number of species will most certainly rise (Larsen & Larsen, 2006). Zingiberaceae is a significant component of the herbaceous ground flora of Thai tropical forests. They mostly grow in damp and humid shady places. They are also found from the lowlands, secondary forests, to the highest elevations in primary forests (Kittipanangkul & Ngamriabsakul, 2008).

1.4.2. Malaysia

Peninsular Malaysia and Northern Borneo represent two of the richest regions in terms of zingiberaceae species in Southeast Asia. Approximately 61 % of the total land area of Malaysia is reportedly covered by tropical rainforests. According to records, there are an estimated 330 to 350 species of Zingiberaceae, including some undescribed species, representing 21 genera (including *Costus*) from East and West Malaysia (Ibrahim, 1992).

1.4.3. Phillipines

There are 15 genera and 103 species of Zingiberaceae recorded in Philippines. Of this number, two genera are monotypic and endemic to the country (*i.e.*, *Leptosalena* and *Vanoverberghia*) while 88 species under 13 genera are unique species. Species endemism is high; 85 percent of the total species are endemic. The largest genus in *Alpinia* with 40 species, followed by *Amomum* (19 species), *Globba* (12 species), *Zingibe*r (10 species), and *Plagiostachys* (6 species). *Hedychium, Kaempferia* and *Curcuma* have two species each, while *Boesenbergia, Etlingera, Leptosolena* and *Vanoverberghia* have 1 species each. Many of the zingiberaceous species are restricted in their distribution and are found in specific habitats. Most species are found in primary forests in the lowlands and only few reach 1,000 m altitudes and above (Madulid, 1996).

1.4.4. China

In flora of China, Wu Te-Lin and Larsen (2000) have reported that there are 20 genera, with one endemic and 216 species in China. Out of 216 species, 141 species are endemic and four are introduced in China. *Alipnia* is the largest genus with 51 species; followed by genus *Zingiber* with 42 species. *Amomum* and *Hedychium* are the other two large

genera with 39 species and 28 species respectively. Yunnan Province is the most concentrate area for zingiberaceae in China.

1.4.5. Bangladesh

The family Zingiberaceae has been investigated for the first time by Rahman and Yusuf (1996) in Bangladesh for its diversity, distribution, and traditional uses by tribal and local peoples. An enumeration of 46 species is reported from Bangladesh under 13 genera so far. Of these, 6 species are new to the flora of Bangladesh. The diversity in the genera *Curcuma* and *Hedychium* is noteworthy with more than 10 species of each. Traditional uses of rhizomes, leaves and flowers of more than 30 species by both tribals and local people have been recorded. Of these 30 species, 16 species are used locally for their medicinal properties. Essential oil has been extracted from both leaves and rhizomes of some species of *Amomum, Curcuma and Etlingera*.

1.4.6. Sri Lanka

In the Flora of Ceylon, Burtt and Smith (1983) have reported that there are 12 genera of Family Zingiberaceae, including genus *Costus* occured in Sri Lanka. Of 36 species, 12 may be endemic; and 3 genera are non-native *(Boesenbergia, Kaempferia* and *Nicolaia).* The largest genus is *Amomum* having 10 species. The zingiberaceae are more abundant in lowland and mid-montane primary forests, less so in secondary forests. They are rarely encountered in the dry zone.

1.4.7. Nepal

Zingiberaceae are represented by 11 genera and 35 species in Nepal; most are tropical and subtropical in distribution. Species of *Cautleya, Hedychium*, and *Roscoea* occur from the temperate to the sub-alpine region. The largest genus is *Hedychium* having 10

species but most of these are cultivated for ornamental purposes. *Roscoea* is the only genus having three endemic species which have very narrow distribution in Nepal.

1.4.8. Bhutan

Smith (1994) recorded 47 species under 14 genera from Bhutan which was published in Flora of Bhutan. This collection has included plants from Sikkim and Darjeeling. *Hedychium* is the largest genus with a record of 13 species.

Fig. 1.4: Distribution of Zingiberaceae in Asian Countries.

Sl. No	AREA	Genus	Species
1	World (Total)	53	1200
2	China	20	216
3	India	22	200
4	Malaysia	21	330-350
5	Nepal	11	35
6	Phillipines	15	103
7	Thailand	26	300
8	Bhutan	14	47
9	Bangladesh	13	46
10	Sri Lanka	12	36

1.5. Distribution in India

The family Zingiberaceae is among the ten largest monocotyledonous families in India. India is one of the richest and diverse regions for Zingiberaceae, having about 22 genera and more than 200 species (Sabu, 2006). However, there are different estimates of

number of genera and species by different researchers. Zingiberaceae is mainly distributed in Eastern Himalaya, North-East India, South India, Western Ghats and Andaman and Nicobar Islands and only a few showing representation in Central India and Western Himalaya (Jain and Prakash, 1995).

From the state of Bihar and Orissa, Haines (1925) listed 37 species under 8 genus. South India (Kerela, Tamil Nadu, Karnataka & Andra Pradesh) represented 10 genera, 65 species and 2 varieties including the naturalised and other ornamental taxa (Sabu, 2006).

Srivastava (1998) has recorded 10 genera and 23 species of Zingiberaceae from Andaman and Nicobar Islands including wild and naturalised ones in the Islands; 5 species are endemic and another 5 species show their distribution to adjoining countries, not occurring in the mainland India. Majority of the species show their occurrence in Indo-malaysian region.

The North East India maintains maximum diversity in Zingiberaceae (next to Malaysia) in having 20 genera and about 122 species, out of total 22 genera and 200 species known from India (Tripathy & Singh, 2006). Out of these, one genus *viz., Parakaempferia* and 31 species are totally endemic to this region. The genus *Hedychium* is the largest one representing with about 36 species in this region. The other important genera are: *Zingiber, Curcuma, Alpinia, Amomum, Globba, Kaempferia, Mantisia, Cautleya* and *Roscoea* occurring with 3 - 8 species each. Also, there are one or two species in each genus namely *Boesenbergia, Caulokaempferia, Costus, Curcumorpha, Etlingera, Hemiorchis, Hitchenium, Parakaempferia* and *Rhynchanthus* (Prakash & Mehrotra, 1996a). The family is well distributed in the North Eastern States, but due to lack of documentation and inventory research, the exact number of the species as well as at the genus level is not cleared till date. The biological wealth in the North-Eastern Himalayan region, including Manipur-Nagaland

belt which happens to be one of the mega-biodiversity hotspots, also has several wild and domesticated species of medicinal Zingiberales (Prakash & Mehrotra, 1996b).

Arunachal Pradesh represents 54 species under 13 genus with 21 species of *Hedychium* as the largest genus from the State (Chowdhery *et al.*, 2009). Deb (1983) has reported 9 genus of Zingiberaceae from the State of Tripura with 24 species in the Flora of Tripura. Kumar (2001) listed 52 species and 5 varieties falling under 14 genera in his book Zingiberaceae of Sikkim. A survey conducted by Borah *et al.* (2012) listed 22 species under 9 genera of Zingiberaceae from Dibrugarh District, Assam. In the survey only the naturally growing species are taken into account. The genera are *Alpinia, Amomum, Boesenbergia, Curcuma, Globba, Hedychium, Kaempferia, Larsenianthus* and *Zingiber.*

1.6. Distribution in Mizoram

Mizoram is a rich biodiversity State in North East India. Intensive research has not been carried out specifically on Family Zingiberaceae. Some botanists have collected and reported certain species of Zingiberaceae having ethno-medicinal value as well as ornamental significance. Lalramnghinglova (2003) had reported 14 species of Zingiberaceae under 8 genera in his book 'Ethno-medicinal Plants of Mizoram'. In flora of Mizoram, Singh *et al.* (2002) also listed out 14 species falling under 10 genera. Zingiberaceae is found throughout the state mainly in tropical and sub-tropical forest as undergrowth and near rivers and streams. It is important to mention that *Mantisia spathulata* (Dancing Girl) was once declared as Mizoram State flower. However, 'Dancing girl' was replaced by 'Red Vanda' recently. The State capital 'Aizawl' is named after *Hedychium greenii* which is known as 'Aidu-chhia' in Lusei language since the species is abundantly grown in the heart of the city in the ancient time. Many other villages like Ainawn, Ailawng, Aithur etc are also named

after the Lusei names of different Zingiberaceae species. Therefore, it can be said that the land and the people of Mizoram are closely related with Zingiberaceae.

1.7. Scope of study

Out of 1200 species of Zingiberaceae recorded throughout the world (Kress *et al*., 2002), only 17 per cent is reported from India. India being rich in biodiversity, it is felt that a large number of Zingiberaceae species may still remain unidentified, particularly in South and North Eastern India, so there is a vast scope to explore Zingiberaceae in these regions. No systematic study of family Zingiberaceae has been carried out so far in Mizoram. The present investigation was carried out during the years 2008-2014 to explore the different species of Zingiberaceae in Mizoram. The prime objective of the present study is focused on the assessment of plant biodiversity of the family Zingiberaceae with reference to their conservation priorities.

1.8. Objectives

The research focused on the following objectives.

1.8.1 To conduct field collection and documentation of Zingiberaceae.

1.8.2 To carry out plant processing and identification of the species and preservation of voucher specimens in the herbarium.

1.8.3. To determine the ecological and conservation status of the species.

1.8.4. To screen the economical, ornamental, rare, threatened and endemic species of Zingiberaceae.

Chapter 2

REVIEW OF LITERATURE

2.1. Introduction

According to Kress *et al*. (2002) Zingiberaceae is the largest family of the order Zingiberales with 53 genera and over 1200 species. Larsen *et al*. (1999) described the distribution of the family occurring throughout the tropics and subtropics with the greatest concentration in the Indo-Malayan region of Asia which includes Malaysia, Indonesia, Brunei, Singapore, Philippines and Papua New Guinea. Jain and Prakash (1995) reported that the family is represented by 22 genera and 178 species in India and is one of the ten largest monocotyledonous families in India

2.2. World's Zingiberaceae

The first documentation of ginger was done by Van Rheede (1692) in his *Hortus Indicus Malabaricus* (Vol. II); the first written account on the plants of India.

The first attempt on detailed study of Zingiberaceae in the 20th century was made by Schumann (1904) who discussed almost all the available species of that time with detailed description, correct nomenclature including all available synonyms and key to the species and genera. Later, Holttum (1950) published a detailed account of the Zingiberaceae of Malay Peninsula. The other notable contributions on Zingiberaceae are those of Burtt (1972), Burtt and Smith (1972).

The generic name *Alpinia* was first used by Linnaeus for *Alpinia racemosa*, a neotropical species. Larsen *et al.* (1998) have done an extensive study on this genus and suggested that *Alpinia* is the largest and most widespread genus in the Zingiberaceae with more than 300 species occurring from Sri Lanka, Western Ghats of India, China, Southeast Asia, Australia and Pacific Islands. Wu & Larsen (2000) in the *Flora of China* listed and described 51 species of *Alpinia* from China. Moo (1978) recognized 13 taxa of this genus in

the Flora of Taiwan. More recently, 14 taxa were recognized by Wang (2000) in the second edition of the Flora of Taiwan. In Thailand, 15 species were enumerated by Larsen (1996). Hanh *et al.* (2014) recorded 31 species of *Alpinia* from Vietnam of which 16 are being used for medicinal purposes by the local people.

The genus *Amomum* Roxb. is the second largest genus of the family Zingiberaceae with about 150 species (Tripathi & Prakash, 1999). The genus was established by Roxburg in 1820. He reported 8 species in his *Flora Indica.* In the *Flora of British India,* Baker (1890 - 1892) reported about 48 species under 5 sections.According to Kiew (1982) and Smith (1985), this genus occurred from the Himalayas to Northern Australia and extends into the central Pacific and widely distributed in Southeast Asia. Larsen (1996) listed 14 species of *Amomum* in his preliminary checklist of Zingiberaceae of Thailand. Sirirugsa (2001) estimated that there are around 15–20 *Amomum* species in Thailand. Holttum (1950) reported 18 species in Peninsular Malaysia. The species of *Amomum* in Cambodia, Laos and Vietnam are revised by Lamxay (2011). In this revision, 35 species and two varieties are recognised with key and detailed description.

The genus Curcuma was coined by Linnaeus in 1753 in his '*Species Plantarum'*. The word Curcuma probably derives from the Arabic word 'kurkum', which means yellow colour (Salvi *et al.,* 2000; Shirgurkar *et al.,* 2001). In 1950, Holttum reported nine species of *Curcuma* from the Malay Peninsula. In 1996, Sirirugsa reported 23 species and 7 unknown from Thailand. Twelve species were reported by Wu and Larsen (2000) in *Flora of China* with key to species and species description. From Thailand, Larsen & Saksuwan (2006) catalogued 34 species. According to Skornickova *et al.,* (2008), the highest diversity of *Curcuma* is in India and Thailand, with at least 40 species in each, followed by Myanmar, Bangladesh, Indonesia and Vietnam. In 2006, Sabu listed 20 species from South India in his

book, *Zingiberaceae and Costaceae of South India*. Rahman and Yusuf (2012) described and illustrated three new species of *Curcuma viz., C. roxburghii, C. wallichii* and *C. wilcockii* from Bangladesh. According to Riswan and Setyowati (1996), the genus is richly represented by 21 species in Indonesia and Wu and Larsen (2000) catalogued 12 species from China. Only 9 species of *Curcuma* are mentioned by Larsen *et al.* (1999) from Peninsular Malaysia and 8 species from Bangladesh. From Ceylon, 5 species of *Curcuma* was reported by Burtt and Smith (1983), and *C. albiflora* Thw. was found to be endemic. Only three species were reported by Madulid (1996) from Phillipines.

Kress *et al.* (2002) reported that *Globba* represents more than 100 species making it the third largest genus of the Zingiberaceae ranking behind *Alpinia* and *Amomum.* Williams *et al.* (2004); Larsen, (1996) and Kress *et al.* (2003) have reported the presence of genus *Globba* from India, Southern China and New Guinea, with the centre of distribution in Southeast Asia, especially Thailand and Myanmar. Holttum (1950), Burtt and Smith (1972) and Larsen *et al.* (1998) categorised *Globba* along with *Mantisia, Gagnepainia* and *Hemiorchis* under the tribe Globbeae.

The genus *Hedychium*, established in 1783 by J.G. Koenig, is one of the ethno-botanically and economically important genera of the family Zingiberaceae. According to Wood *et al.* (2000), *Hedychium* J.G. Koenig is consisting of 65 species worldwide. However, Sirirugsa & Larsen (1995) reported about 80 species and are mainly distributed in India, South China, and Southeast Asia. Warren and Peters (1968) have studied *Hedychium* and established that this genus is widely cultivated for perfume, medicinal and for its horticultural significance. Saleh *et al.* (1982) reported the molluscicidal activity of the species. Gopanraj *et al.* (2005) and Shrotriya *et al.* (2007) also well established the antimicrobial activities and anti-inflammatory and analgesic effects of the genus respectively.

The genus *Boesenbergia* was proposed in 1891 when Otto Kuntze observed that *Gastrochilus* Wall. is a homonym of *Gastrochilus* D.Don (1825). In 1974, Rao and Verma regarded it as belonging to the monotypic genus *Curcumorpha*. This change was countered by Larsen (1997) but Kress *et al.* (2002) and Gao *et al*. (2004) stated that this nomenclature is continued to adopt by many taxonomist and still a subject of controversy. Saensouk and Larsen (2001) reported about 80 species of *Boesenbergia* ranging from India to South East Asia in distribution. Larsen (2003) estimated 25 species in Thailand. According to Mabberley (1997), *Boesenbergia* is represented by about 30 species in Indo-Malayan region. From Bangladesh, Rahman and Yusuf (1996, 1997) showed that the genus *Boesenbergia* is represented in the flora by only one species *i.e. B. longiflora*. Later, Yusuf and Rahman (2003) reported a new species *Boesenbergia islamii* from Bangladesh, with detailed key and description. Tuchinda *et al.* (2002) and Tewtrakul *et al.* (2003) extracted anti-inflammatory cyclohexenyl chalcone derivatives and HIV-1 protease inhibitory substances respectively from the rhizome of *Boesenbergia pandurata*.

2.3. India's Zingiberaceae

The earliest published record of Zingiberaceae taxa in India is in *Hortus Malabaricus* by Hendrik Andriaan Rheede (1678-1693). He was then the Dutch Governor at Cochin, and he with the assistance of local physicians, artists and interpreters prepared the diagrams and short description in Latin. There are nine species of Zingiberaceae published in the Eleventh Volume of *Hortus Malabaricus* with their binomial identity, such as *Elettaria cardamomum* (L.) Maton; *Curcuma zedoaria* (Christm.) Roscoe; *Kaempheria rotunda* L., *Boesenbergia rotunda* (L.) Mansf.; *Curcuma longa* L.; *Zingiber officinale* Roscoe; *Zingiber zerumbet* (L.) Roscoe; *Alpinia nigra* (Gaertn.) Burtt; *Kaempheria galanga* L.

A notable contribution to India botany made by Roxburgh was considerably more than that of any other. His work was published as *Plants of Coast of Coromandel* (1795-1820). In this publication, he included 7 genera and 15 species of Zingiberaceae. However, the major part of Roxburgh's findings on Indian botany is incorporated in his *'Flora Indica'.* Part of Roxburgh's manuscript of his *Flora Indica,* edited by William Carey, was published posthumously, along with additions by Wallich under the title *Flora Indica;* two volumes were issued, Vol. I in 1820 and Vol. II in 1824. This manual describes 65 species of Zingiberaceae under the class Monandria Monogynia distributed over 8 genera.

Following Roxburgh, Wallich described some zingibers in his *Plantae Asiaticae Rariores* (Wallich, 1830-1832). Wallich (1828-1849) in his "Catalogue" (a numerical list of dried specimens of plants in East India Company's Museum) included many of the Indian Zingiberaceae known till then. Robert Wight explored the South Indian flora and included 7 genera and 14 species of Zingiberaceae in his *Icones Plantarum Indiae Orientalis* (Wight, 1838-1853).

Hooker's monumental work, *Flora of British India* (1872-1897) still remains as the only authentic floristic work on the Indian subcontinent. Baker (1890-92) presented an account of Zingiberaceae in Hooker's *Flora of British India*. He described 19 genera and 224 species of Zingiberaceae, some of which were recorded as of doubtful nature. Fischer (1928) described 34 species under 9 genera, *viz., Alpinia, Amomum, Costus, Curcuma, Elettaria, Globba, Hedychium, Kaempferia* and *Zingiber* from South India in *Flora of the Presidency of Madras.* But in this report, the entire geographical area of South India was not covered.

There are different estimates of the number of genera and species of Zingiberaceae in India by different workers. Karthikeyan *et al.* (1989) enumerated 22 genera and 167 species and 13 varieties of Zingiberaceae from India distributed mainly in Himalayas region

particularly from Central to North East India, Peninsular India, and also in Andaman and Nicobar Islands. Again, Jain and Prakash (1995) in an article on phytogeography and endemism of Zingiberaceae reported 22 genera and 178 species from India distributed in Eastern Himalaya, North East India, Western Ghats and Andaman and Nicobar Islands and only a few showing representation in Central India and Western Himalaya.

Sabu (2006) described 61 species and 2 varieties under 9 genera *(Alpinia, Amomum, Elettaria, Zingiber, Curcuma, Hedychium, Boesenbergia, Kaempferia, Globba)* from South India (Andra Pradesh, Karnataka, Tamil Nadu, Kerela and Union Territories of Mahe and Pondicherry) in his book *Zingiberaceae and Costaceae of South India*. In Tamil Nadu alone, Henry *et al.* (1989) reported that Zingiberaceae is represented by 9 genera and 29 species. Mitra (1958) catalogued 88 species with 9 varieties of Zingiberaceae under 13 genera in *Flowering Plants of Eastern India,* Vol-I. He reported that *Hedychium* is the largest genera having 19 species with 4 varieties. Lesser known genera like *Hitchenia, Roscoea, Hemiorchis, Matisia* are listed in this collection. Haines (1925) described 37 species of Zingiberaceae under 8 genera *viz., Globba, Curcuma, Gastrochilus, Kaempferia, Hedychium, Amomum, Zingiber* and *Alpinia* in *The Botany of Bihar and Orissa.*

Vasudeva Rao (1986) listed 14 species belonging to 8 genera categorised under the indigenous taxa and 5 species included as non-indigenous taxa from Andaman and Niocobar Islands. Later, Srivastava (1998) studied on Zingiberaceae of Andaman and Nicobar Islands comprehensively and indicated that there are 23 species under 9 genera *(Alpinia, Amomum, Boesenbergia, Curcuma, Globba, Hedychium, Hornstedtia, Kaempferia* and *Zingiber)* including wild and naturalised ones in the islands. According to him, 5 species *(Alpinia manii, Boesenbergia albolutea, Globba pauciflora, Hornstedtia fenzlii, Kaempferia*

siphonantha) are endemic to these islands and another 5 species showed their distribution to adjoining countries, not occurring in the mainland India.

The genus *Alpinia* Roxb. of South India is revised by Mangaly and Sabu (1992). This region represented eight species including a new species, *Alpinia smithiae*.

A very successful project on 'Indian Zingiberaceae' was done by Thomas and Sabu (2012a). During this project two new species of *Amomum, i.e. A. agastyamalayanum* and *A. newmanii* were described and illustrated from the Western Ghats of Kerala. They also added *Amomum fulviceps* and *Amomum nilgiricum* from the Western Ghats (Thomas *et al*, 2009, 2012a). A new species of *Amomum andamanicum* is also reported by Thomas *et al.* (2010) from Andaman & Nicobar Islands. During an intensive botanical exploration for the revision of Indian *Amomum*, a new species, *Amomum nilgiricum* was reported by Thomas *et al.* (2012b).

According to Jain and Prakash (1995) *Hedychium* is the largest genus of the family in India with about 43 taxa, and are mainly distributed in North Eastern States with 16 endemics, of which only 4 are represented in South India.

2.4 North East India's Zingiberaceae

The North East India maintains maximum diversity of Zingiberaceae in India with 20 genera and about 122 species (Karthikeyan *et al.*, 1989). Rao & Verma (1969) listed 10 species of *Hedychium* from Khasi and Jaintia Hills. Deb (1983) reported 24 species under 9 genera from Tripura. Balakrishnan (1983) described 28 species with 5 varieties under 12 genus from Jowai. Kumar (2001) reported 52 species and 5 varieties under 14 genera from Sikkim. Chowdheri *et al.*, (2009) catalogued 54 species under 13 genera from Arunachal Pradesh. Rao & Verma (1972) listed 69 species under 18 genera from Assam.

Tripathy and Prakash (1999) described and illustrated *Amomum jainii* from Meghalaya. During the course of a revisionary study of the *Zingiberaceae* of North East India, a new species, *Amomum vermanum* is described and illustrated by Tripathy and Prakash (2000) from Garo Hills of Meghalaya. Thingam *et al.* (2013) reported *Globba sherwoodiana* from Manipur for the first time in India. Tripathi and Singh (2006) described and illustrated 7 species of genus *Zingiber* from North East region comprises of the States of Assam, Arunachal Pradesh, Manipur, Meghalaya, Nagaland, Sikkim, Tripura and Darjeeling district of West Bengal.

Singh *et al.* (2002) reported 13 species from Mizoram in the Flora of Mizoram Vol-I. Lorrain (1940) mentioned a few species of the Family Zingiberaceae in Mizoram in his book entitled "Dictionary of the Lushai Language". Saptawna (1990) reported 5 species of Zingiberaceae which are used as medicine. Chawngkunga (1996) also reported 5 species of Zingiberaceae with their ethno-medicinal value. Rozika (2001) mentioned 5 species of Zingiberaceae in his book "Ramhmul Damdawite". Sawmliana (1998) mentioned 11 species of Zingiberaceae.

The most notable contribution is made by Lalramnghinglova (2003); he documented 13 species under 8 genera in his book 'Ethnomedicinal Plants of Mizoram' with their taxonomical character, botanical description and ethno-botanical uses and later added the records of endemic species such as *Rhycanthus longiflorus, Mantasia spathulata.* Skornickova *et al.* (2003) reported a new species of *Curcuma rubrobracteata* from Ngengpui Sanctuary, Lawngtlai, Mizoram. Prasantkumar *et al.* (2005) also re-discovered *Rhynchanthus longiflorus* from Saireptlang, Lunglei District, Mizoram. Singh & Kumar (2011) reported *Globba wardii* from Blue Mountain (Phawngpui National Park), Mizoram. Thomas *et al.*

(2013) reported two new species of Zingiberaceae *viz. Amomum dampuianum* and *Amomum mizoramensis* from Dampui Reserve Forest in Mamit District of Mizoram.

Chapter 3

STUDY AREA:

MIZORAM

3.1. Geographical location

Mizoram is a mountainous region which became the 23rd State of the Indian Union in February, 1987. It was one of the districts of Assam till 1972 when it became a Union Territory. Mizoram is located between 21^0 58' N and 24^0 35'N latitudes and $92^0$15' E and 93^0 29' E longitudes in the North-Eastern part of India (Anonymous, 2001). The Tropic of Cancer passes through the southern periphery of Aizawl City at 23^0 30 'N Latitude. Elevation ranges from 40 m at Bairabi to 2157 m at Phawngpui (Blue Mountain), the highest peak in the State (Pachuau, 1994). The total geographical area is 21,081 sq. km which is sandwiched between Myanmar in the East and South and Bangladesh in the West. It is bounded by the State of Assam and Manipur on the North. Mizoram occupies an area of great strategic importance in the North Eastern corner of India. It has a total of 772 km international boundary with Myanmar and Bangladesh.

Initially there were only three districts in Mizoram *viz.*, Aizawl district in the north, Lunglei district at the centre of the state and Chhimtuipui district at the southernmost. Presently for administrative convenience, the Aizawl district has been divided into five districts, *viz.* Aizawl district, Champhai district, Mamit district, Kolasib district and Serchhip district. Lunglei remained undivided, while Chhimtuipui district was again divided into two districts, *viz.,* Saiha district and Lawngtlai district. Thus, the state consists of 8 districts and has about 700 villages and three Autonomous District Councils, *viz.*, Lai Autonomous District Council, Mara Autonomous District Council and Chakma Autonomous District Council (Anonymous, 2013).

3.2. Climate

Mizoram enjoys a moderate climate throughout the year owing to its tropical location, and the temperature ranges from 10˚C to 32˚C annually. The region falls under the direct influence of South-West Monsoon. The state enjoys tropical, sub-tropical and temperate climates with high rainfall (2000-3500 mm) and high humidity (upto 100%) (Anonymous, 2008). The average annual rainfall in Aizawl and Lunglei are 208 and 350 centimetres respectively. Mizoram has great natural beauty and endless variety of landscape and is also very rich in flora and fauna. Almost all kinds of tropical trees and plants thrive in Mizoram. The hills are marvelously green as well. Four seasons have been recognized in Mizoram:

1. Spring – February-April and temperature ranges from 11˚C-29˚C;
2. Summer – May-August, temperature ranges from 21˚C-32˚C;
3. Autumn – September-October and temperature ranges from 20˚C-27˚C
4. Winter – November-January and temperature ranges from 8˚C-20˚C.

The rainy season lasts from May to September and dry season lasts from October to April. Winter in Mizoram is normally rain-free.

3.3. Demography

As per details from Census 2011, Mizoram has population of 1,097,206; of which male and female are 555,339 and 541,867 respectively. Sex Ratio in Mizoram is 976 i.e. for each 1000 male, which is below national average of 940 as per census 2011. The population Density of Mizoram is 52 per sq km which is also lower than national average 382 per sq km. The population of Mizoram forms 0.09 percent of India in 2011. Literacy rate in Mizoram

has seen upward trend and is 91.33 percent. Of this, male literacy stands at 93.35 percent while female literacy is at 86.72 percent (www.census2011.co.in).

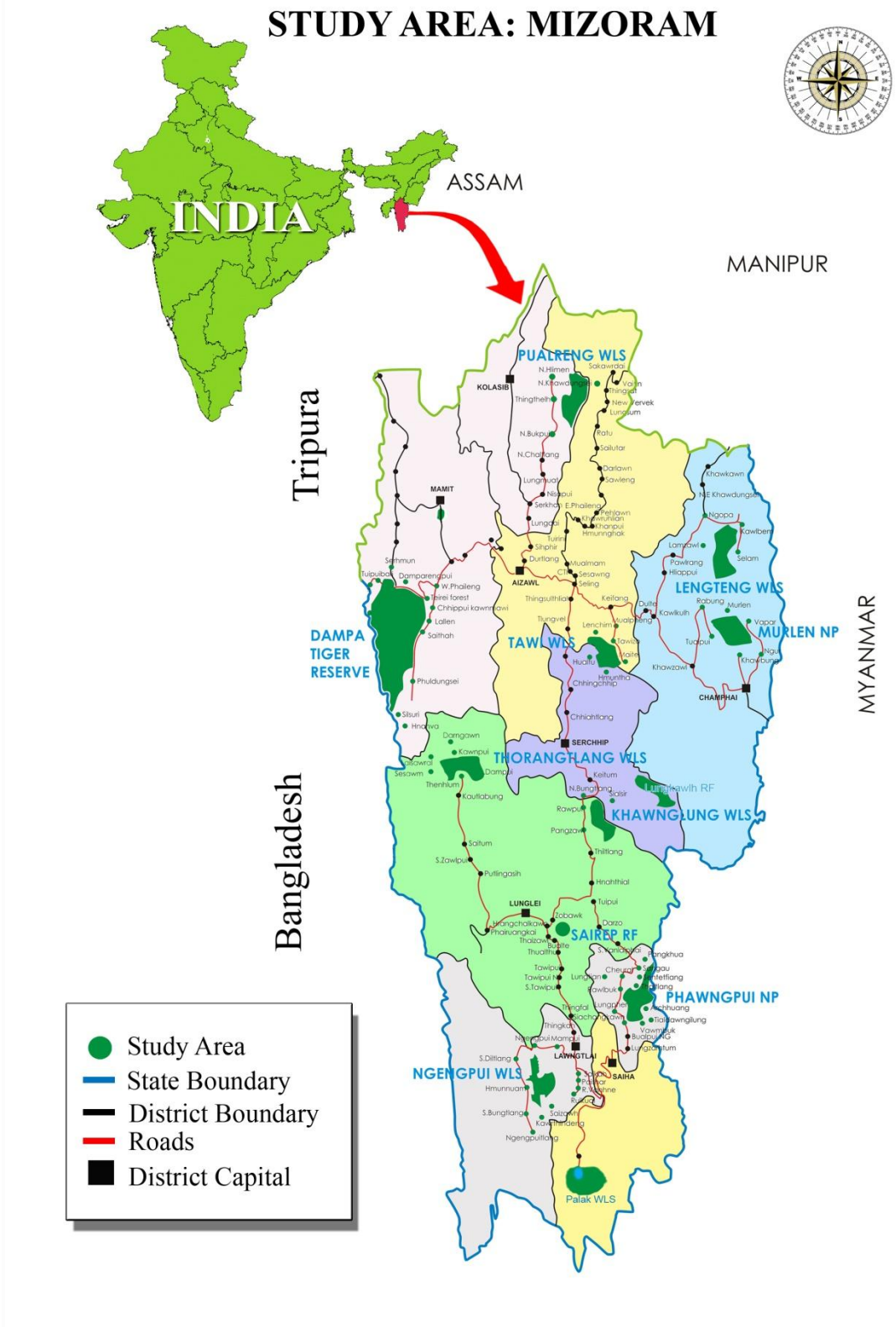


Fig. 3.1: A map showing the location of study area.

3.4. Geomorphology

The soil of Mizoram is generally young, immature and sandy. In the study area, sedimentary rocks are seen at some places in the base lines and in watersheds. Rock plates and hard shales are present in the upper areas, where stone quarries are laying along the side of the road. Soils of the study area are porous, sandy loam; humus and the top soil have been washed away by run off. The soils of Mizoram are classified by Sarker and Nandy (1976) into three orders of soil taxanomy : (i) Entisols, (ii) Inceptisols and (iii) Ultisols (USDA, 1988) followed by Hrahsel (1988), Singh and Datta (1989), Pachuau (1994) and Saithantluanga (1997).

The soils of the study area also falls under the above three orders. They are generally young, immature and sandy. The surface soils are dark, highly leached and poor in bases, rich in iron and have low pH values ranging from 4.5-6.0 *i.e.,* averagely acidic. They are well drained, rich in organic carbon, low in phosphate content and high in available potash. The surface soil textures are loam to clay loam with clay content increasing in depth. The pH and organic carbon content decreases with the increase in depth. They are capable of providing substancial oxygen supply for plant growth and have capability to retain moisture for sufficient supply of oxygen throughout the year. The percentages of clay, silt and sand within 50cm of the surface is 15-30%, 35-45% and 25-45% respectively (Anonymous, 1999).

3.5. Rivers and lakes

There are many rivers in Mizoram. The largest river is *Tlawng* (Dhaleshwari) which is 185.15 km in length. The other important and useful rivers are Tut (Gutur), Tuirial (Sonai), Tuichang, Mat, Tuipui, Teirei, Tuirini, Serlui and Tuivawl. The river Tlawng passes from south to north in the western part of Mizoram and then joins Barak River in Cachar plain. The river Tuivawl and its tributary Tuivawl forms an important drainage system in the

North eastern part of Mizoram. These rivers form the borderline between Mizoram and Manipur and finally join Barak river of Tipaimukh.

The Koldoyne (Chhimtuipui) which originates in Myanmar, is an important river in the south Mizoram. It has four tributaries *viz.,* Mat, Tuichang, Tiau, Tuipui. It forms boundary line between India and Myanmar in the south and eastern part of Mizoram. The western part is drained by Khawthlangtuipui (Karnaphuli) and its tributaries *viz*., Tuichang, Phairuang, De, Kau etc. These rivers originate from central hills of Mizoram and flow westwards into Bangladesh at Tlabung and finally join Bay of Bengal.

There are a few beautiful lakes in the State that provide habitat for the growth of aquatic vegetation and tropical and subtropical vegetation surrounding them. The most important lakes are Palak, Tamdil, Rungdil and Rengdil. The Palak Lake is situated in Chhimtuipui District in Southern Mizoram and covers an area of 30 Ha. It is believed that the lake was arising as a result of an earthquake or a flood. The Tamdil lake is a natural lake situated 110 kms from Aizawl (Singh *et al.,* 2002).

3.6. Vegetation and forest types

The forests are one of the important resources for the socio economic development of the Mizo people. The actual forest cover of the state at present is 19,054 sq km which constitute 90.38 % of the geographical area, and is the highest among the States of the country. Out of the 19,054 sq km forests, 138 sq km are very dense forests, 5,900 sq km are moderately dense forests and 13,016 sq km are open forests. (Anonymous, 2011).

Based on past studies as well as from the field observations, Singh *et al.,* (2002) described the forest types of the State based mainly on altitude, rainfall and dominant species composition. The classification is as follows:-

3.6.1. Tropical wet evergreen and semi-evergreen forests

These forests usually occur below an altitude of 900m and form one of the major forest types of the State with rich species diversity. Patches of these forests can be seen usually on the steep slopes, rocky and steady river banks and areas not suitable for shifting cultivation. The exact distinction between the evergreen and semi-evergreen forests is difficult as they occur in the areas of similar characteristics where rainfall averages between 2,000-2,500mm annually and temperature varies between 20^{o}C to 22^{o}C. Tropical wet evergreen forests are met usually in southern and western part of Mizoram, while semi-evergreen forests occur in northern, north-western and central part of the State.

The tropical wet evergreen forests exhibit clear zonation or canopies consisting of an admixture of numerous species with dense and impenetrable herbaceous undergrowth. Most of the species of the top canopy are evergreen trees with tall boles. Cauliflory is rather common. The middle and lower canopies are dense, evergreen and diverse. Epiphytes and parasites are few. Tree ferns, aroides, palms, ferns, orchids, bryophytes and lichens are fairly common. Lianas are frequent and conspicuous, sedges and grasses are common in humid places or along the banks of rivers and rivulets. Species of *Musa* are also common along the streams on hilly slopes.

In exposed and drier areas, having a thin of soil, deciduous elements along with some evergreen trees are found. Sometimes these are grouped as distinct type, referred as tropical moist deciduous forests. The distinction between the tropical evergreen forests and tropical moist deciduous forests is difficult as they are found in the small hill ranges.

The third storey of canopy consists of smaller trees and shrubs with maximum floristic diversity.

3.6.2. Montane sub-tropical forests

These forests are usually found between 900 and 1,500 m altitude in the eastern fringes bordering Chin Hills of Myanmar, and places which are cooler and have less precipitation. Sub-tropical vegetation shows mixed pine forests. The common species of these forests are *Castanopsis purpurella, Duabanga grandiflora, Myristica spp., Phoebe goalparensis, Pinus kesiya, Podocarpus neriifolia, Prunus cerasoides, Quercus acutissima, Q.semiserrata, Schima wallichii,* etc.

3.6.3. Temperate forests

These forests usually occur above the elevation of 1,600m in areas like Lengteng, Naunuarzo, Farpak, Thaltlang, Phawngpui reserve forests and display impenetrable virgin primary forests. These forests are not typical temperate forests as found elsewhere in eastern Himalaya. The predominant arboreal elements in the forests are *Pinus kesiya, Actinodaphne microptera, Betula alnoides, Exbucklandia populnea, Elaeocarpus serratus, Dillenia pentagya, Michelia doltsopa, M. Champaca, Garcinia anomala, Schisandra neglecta, Photinia intergrifolia, Litsea salicifolia, Myrica esculenta, Lithocarpus dealbata, Rhododendron arboreum,* etc.

3.6.4. Bamboo forests

Bamboos usually grow as an under-storey to the tree species in tropical evergreen and sub-tropical mixed-deciduous forests, whereas *Melocanna baccifera* forms dense or pure forests in certain areas in the State. Large tracts of bamboos are seen throughout Mizoram but their distribution is somewhat restricted to above 1,600m. They occur mostly between 40m and 1,520m in tropical and sub-tropical areas. Few species occur in temperature areas in Blue Mountain and Mount Chalfilh. It appears that bamboos have resulted from jhuming system of

cultivation (Deb and Dutta, 2004). For practicing jhum cultivation the forests are burnt and tree species are destroyed but the bamboo rhizomes throw out new culms as soon as favourable temperature and seasonal monsoon arrive. Therefore, in abandoned jhumland they are the first colonizer and grow rapidly. Some important associates found growing along with bamboos are *Emblica officinalis, Litsea monopetala, Pterospermum acerifolium, Terminalia myriocarpa, Caryota mitis, Artocartus chama, Duabanga grandiflora, Albizia procera, Gmelina arborea, Syzygium* species (Singh *et al*., 2002).

3.6.5. Quercus forests

These forests are mostly found intermingled in sub-tropical and temperate areas. Pure patches or predominate *Quercus griffithiana* is present near Champhai-Baite hill ranges and its distribution is restricted to other small areas in the eastern part of Mizoram. *Lithocarpus dealbata* is other main species (Singh *et al*., 2002).

3.6.6. Jhumland

Jhumlands are very common in Mizoram. They are classified variously as current Jhumland, old Jhumland and abandoned Jhumland. Jhumlands are more prevalent in eastern Mizoram where extensive and intensive Jhumming is practiced. Similarly, the areas in western side in Lunglei district towards Bangladesh have also Jhumlands. Bamboos, grasses, members of Asteraceae and Melastommaceae are most abundant in Jhumlands.

3.7. Protected areas and other natural forests

The present study is carried out in 10 Protected Areas (Two National Parks and seven Wildlife Sanctuaries and one Tiger Reserve) and 4 Natural Forests of Mizoram. The study sites are as listed below:

Sl. No.	Name of the Protected areas	Area (sq km)	District
1	Phawngpui National Park	50.00	Lawngtlai
2	Murlen National Park	100.00	Champhai
3	Pualreng Wildlife Sanctuary	50.00	Kolasib
4	Lengteng Wildlife Sanctuary	60.00	Champhai
5	Tawi Wildlife Sanctuary	35.75	Aizawl
6	Thorang Wildlife Sanctuary	50.00	Lunglei
7	Khawnglung Wildlife Sanctuary	35.00	Lunglei
8	Ngengpui Wildlife Sanctuary	110.00	Lawngtlai
9	Palak Wildlife Sanctuary	250.00	Saiha
10	Dampa Tiger Reserve	500.00	Mamit
11	Dampui Reserve Forest	2.55	Mamit
12	Sairep Natural Forest	5.00	Lunglei
13	Lungkulh Virgin Forest	5.00	Mamit
14	Lungkawlh Reserve Forest	5.00	Serchhip

3.8. The inhabitants

In Mizoram, 16 Scheduled Castes, 14 Scheduled Tribes and 37 Sub-tribes have been recognized (Anonymous, 1991). Shakespeare (1912) divided the Lushai (Mizo) into a number of sub-tribes or clans and sub-clans. Dutta (1992) so far traced fifteen ethnic groups or population in Mizoram, such as *Lusei, Paihte, Hualngo, Tlau, Thado, Ralte, Hmar, Mara* (Lakher), *Pawi (Lai), Bawm, Pang, Chakma, Riang*, *Biate* and *Mog.*

Out of the above mentioned fifteen ethnic groups, 6 minority ethnic groups or communities form the “inhabitants” of the study area, such as (i) *Mizo* (Lusei) (ii) *Mara*

(Lakher), (iii) *Lai* (Pawi), (iv) *Paihte* (v) *Chakma* (vi) *Bru* who are a very distinctive people rich in old-age traditions, cultures and customs, and continue to retain their respective dialects and ethnic identity (Lalramnghinglova, 2003). A brief account of the inhabitants of study area is presented below:

3.8.1. Mizo *(Lusei)*

The Mizos are formerly known as *Lushais* and their language (i.e., *Lushai language or Duhlian)* has now became *"Mizo language"* (Phukan, 1992; Thanga, 1992). They are the dominant tribe in Aizawl, Lunglei, Champhai, Serchhip, Mamit and Kolasib Districts of the study area. The *Mizos* believed that they came from a cave called *'Chhunlung'* or *'Sinlung'* a *'closed-stone'* (Thanga, 1978) which is said to be located at Szechwan Province in China or bordering the Shan-state in Eastern China (Sangkima, 1992).

The Mizos speak Lushai (Mizo) language which belongs to the *Tibeto-Burman* branch of the *Sino-Tibetan* language family (Grieson, 1908; Changli, 1992; Rui, 1992). A great majority of ethnic Mizo people are Christians. Agriculture is the main occupation of Mizos by practicing *Shifting* cultivation.

3.8.2. Mara

The true name and the name by which they call themselves is *'Mara'* but they are called as *"Lakhers"* by the surrounding tribes (Lorrain, 1921). They are known as *'Shamtu'* in Myanmar, *'Shindu'* in Arakan. They occupy the south-eastern corner of Mizoram. They came from Haka, the Chin Hills of Myanmar and they speak Mara language. They live in eastern hills and the valleys of *Kolodyne* river. The principal *Mara* clans have been classified into royal, patrician and plebeian clans (Parry, 1932). They are extremely sensitive to their

peculiar identity (Chatterjee, 1990). Agriculture is the main occupation. The Maras are expert cotton growers and women are good weavers.

3.8.3. Lai

Lai people are known as *Pawi* or *Chin,* because most of their settlements were in the Chin Hills of Burma (Singh, 1995). According to tradition, they came from Haka and Klangklang Sub-division of the Chin Hills of Myanmar (Anonymous, 1994). According to Hengmanga (1992), Lai people came down from China in 200-100 B.C.

Lai People live around the Blue Mountain and in-between Kolodyne River and Chakma Autonomous District in Chhimtuipui District of South Mizoram. They speak their own language called, **'Lai Hawlh'** (Language of Lai). Their dialect belongs to the Tibeto-Burman type of Central-Chin Group along with Lushei, Lakher and Zahau tribes (Grieson, 1908). There are over 160 clans and sub-clans among the Pawi tribe. The principal clans are *Hnialum, Chinzah, Hlawncheu, Hlawnchhing, Khenglawt* and *Fanai* (Anonymous, 1994). *Jhuming* agriculture is their main occupation.

3.8.4. Paihte

The *Paites* are one of the constituting tribes of the Zomi/Zos who inhabit India, Burma and Bangladesh. The word *Paite* means "a group of people marching" (pai-march; te - "plural maker"). The *Paites* are a recognised scheduled tribe in Manipur as well as in Mizoram. The *Paites* are concentrated in Manipur, a northeastern state of India. They are dominant in Lamka Town of Churachandpur of Manipur state. Almost all ethnic Paites follows Christianity. There is also a large *Paite* population in Mizoram and live around Lengteng hills in the Northern part of Mizoram in Champhai district. They are well integrated in the *Mizo* group which consists of many very similar tribes.

3.8.5. Chakmas

"Chakmas' means people of *'Tsak'* clan who are the progenitors of the Burmese race, and the Arakanese word *'Khyeng-tha'* signifies people or nation living near water (Sen, 1992). *Chakmas* inhabit the western part of Mizoram bordering Bangladesh and Tripura state. They are habitually and culturally nomadic, moving from one place to the other and live temporarily near or along rivers. The river valleys of *khawthlangtuipui* and *Tuichawng* are dominated by Chakma villages. They speak Chakma language which has close affinities with Bengali language (Singh, 1995). Bhuddism is their religion and agriculture is their main occupation.

3.8.6. Bru or Riang

The *'Riangs'* of Tripura are called *'Tuikuk'* in Mizoram and they called themselves *'Bru'* which means man. They came to Mizoram from the Chittagong Hill tracts of Bangladesh (Lalramnghinglova, 2003).

They are distributed in the western part of Mizoram and live in the villages of Dinthar, Uiphum, Nghalimlui, Zehtet, Parva, Chamdur, Zawlpui, Zawlnuam etc. They speak 'Bru language' which belongs to the Non-Khamer family (Grieson, 1908). Like Chakmas, they exihibit a nomadic way of life and live near the forests or rivers. Principally, they are animists (Chatterjee, 1978). Their main occupation is *Jhum* farming.

Chapter 4

METHODOLOGY

4.1. Literature research

A literature search is a systematic and thorough search of all types of published literature in order to identify a breadth of good quality references relevant to a specific topic. Extensive literature research was conducted in a systematic way by collecting primary information as well as secondary data from various sources *viz.*, manuals, published books and journals, internet data and documents. The basic information of the indigenous knowledge such as vernacular names of the species, uses and utilization of the species, occurrence of rare, endangered and threatened species has also been consulted so as to identify, locate and determine the species of the family, Zingiberaceae.

4.2. Field collection and documentation of Zingiberaceae

The study areas were visited three times in a year, *viz.*, pre-monsoon (March to May); monsoon (June to August); and post-monsoon (September to November). The best collecting season is rainy season or monsoon period where most of the Zingiberaceae produce flowers. Since they are annuals, many of the species normally withers and left themselves with dry leaves in the winter season starting from November to the next February. The plant specimens were collected from different study areas in every stage of their growth and reproduction. The collected plant specimens were documented in the format as given below:

(1) Scientific name

(2) Family

(3) Local Name

(4) Habit/Habitat

(5) Locality

(6) Botanical description

(7) Phenology

(8) Distribution

(9) Associates

(10) Line drawing/Photographs.

(11) Status/Category (rare/endangered or endemic).

(12) Uses (ethno-botanical, economical and ornamental).

4.3. Plant Processing and Herbarium Method

The plants collected are either pressed on the spot or collected in polythene bags and pressed after leaving the collection sites. The plant specimens are usually collected in flowering stage and at three twigs of each specimens and tagged immediately; field characters and locality are also noted. For collection and pressing and preparation of herbarium specimens, the standard methods suggested by Jain and Rao (1977) were strictly followed with suitable modifications. Poisoning of the plants was done after the drying processes so as to prevent the formation of abscission layer and decay by dipping the specimens in a saturated solution of mercuric chloride and ethyl alcohol (Kew mixture). During the process of poisoning, rubber / plastic gloves, brush, forceps and nasal mask were also used because mercuric chloride is highly poisonous and corrosive. The plants were pressed in between the sheets of blotting paper and pressed for about 24-48 hrs. The pressed plant specimens are dried in sunlight or in artificial heat and the blotting papers are changed

frequently till the plant specimens are dried (Subramaniam, 2005, Martin, 1995, Womersley, 1981).

After drying, the specimen were mounted for permanent record on herbarium sheet of the standard size 29 cm x 42 cm and label (10cm x 12cm) is pasted on the lower right hand corner. The specimens are arranged in their cases according to Bentham and Hooker (1883) system of classification.

4.4. Plant identification and preservation

The identification of plants has been done with the help of protologues, taxonomic revisions, monographs and relevant floristic account. The tentatively identified plants were later confirmed by consulting the herbaria of Botanical Survey of India (BSI) Shillong, Central National Herbarium (CNH) Howrah, Calcutta and Calicut University; and taxonomic literature such as floras, manuals, journals, monographs and internet facilities are also consulted. The collected plant specimens are preserved in the form of bottle specimens in the laboratory or life-forms in herbal garden of Mizoram University, Aizawl and the voucher specimens are deposited in the Herbarium of Mizoram University, (acronym MZU), Aizawl.

4.5. Determination of ethno-medicinal, economical and ornamental species

The basic interview technique was adopted for the determination of ethno-medicinal, economical and ornamental uses of the plant specimens. Open-ended and semi-structured interviews, which are used in qualitative data collections, were adopted when necessary. Key informants, knowledgeable persons and practitioners of the study area were taken to the forests for identification and collection of the specimens. Based on the information collected from the local practitioners, ethno-medicinal species as well as economical and ornamental species were identified. Journals, Books, monograph and internet facilities have also been

extensively utilized for the determination of ethno-medicinal, economical and ornamental species, besides the help of the experts of National Herberia as mentioned earlier.

4.6. Determination of rare, threatened and endemics species

Quantification of plant specimens was screened with the help of IUCN Red List Categories (2001), Red Data Book of India (Nayer and Sastry, 1987) and Rare and Endangered Species of India published by Botanical Survey of India. The Indian Wildlife (Protection) Act 1972 was also consulted for threatened species. The endemics, rare and endangered species were assessed and determined with their ecological security, conservation, multiplication and sustainable development.

Chapter 5

RESULTS

Taxonomical description

Zingiberaceae are generally perennial herbs, terrestrial, rarely epiphytic, aromatic, with fleshy, creeping horizontal tuberous or non-tuberous rhizomes, often with tuber-bearing roots. Stems usually short, replaced by pseudostems formed by leaf sheaths. Leaves distichous, simple, those toward base of plant usually bladeless and reduced to sheaths; leaf sheath open; ligule usually present; petiole present or not, located between leaf blade and sheath; leaf blade sub-orbicular or lanceolate to narrowly strap-shaped, rolled longitudinally in bud, glabrous or hairy, mid vein prominent. Inflorescence terminal on the leaf shoot or borne on a separate leafless shoot arising from rhizomes, cylindric or fusiform, sometimes globose, lax to dense, few to many flowered, sometimes a raceme or spike; bracts and bracteoles present, colored. Flowers solitary in the axils of bracts or in cincinni, with or without bracteoles, bisexual, epigynous, zygomorphic. Calyx tubular or truncate, usually 3-toothed, split on one side. Corolla proximally tubular, distally 3-lobed; lobes varying in size and shape. Stamens or staminodes 6, in 2 whorls. Lateral staminodes of outer whorl petaloid, or forming small teeth at base of labellum. Labellum formed from lateral 2 staminodes of inner whorl. Fertile stamen 1 with a 2-celled anthers and usually two petaloid stamimoides; filament long or short, longer than the labellum, jointed to corolla tube at the base, sometimes jointed to the labellum or to the staminoides; anther locules 2. Ovary inferior, 3-loculed initially, 1-3-loculed when mature; ovules numerous per locule; stigma appearing above anther, funnelform, papillose. Fruit a capsule, fleshy or dry, dehiscent or indehiscent, sometimes berrylike. Seeds few to many, arillate; aril often lobed or lacerate.

About 50 genera and 1200 species are distributed in pan-tropical with centre of diversity in South and South East Asia, some species in America and subtropical and warm-temperate Asia. In India, about 22 genera and 200 species are recognised so far; and 14 genera and 52 species are recorded in the present study for Mizoram.

KEY TO THE GENERA

1a. Ovary trilocular (3-celled); ovules axile placentation……..3

1b. Ovary unilocular (one-celled); ovules in 3 parietal placentation…….2

2a. Lateral Lateral staminodes short elliptic, resembling and arising at the same level as the corolla lobes……...…….5.9. *Globba*

2b. Lateral staminodes long, linear or spathulate, arising on either side of the filament……...5.12. *Mantisia*

3a. Lateral staminodes large and broad……..4

4a. Inflorescence terminal on a leafy stem…….…..5

5a. Filament long, densely numerous flowers……5.10. *Hedychium*

5b. Filament very short or absent, 1 or 1-4 flowers……...…….6

6a. Flowers yellow or whitish, labellum orbicular or broadly ovate, apex entire ……5.4. *Caulokaempferia*

6b. Flowers yellow or orange, labellum broadly cuneate, apex emarginated……..…5.5. *Cautleya*

4b. Inflorescence basal or arising from long rhizomes……....7

7a. Inflorescence compact with a terminal plume of barren bracts; bracts adnate forming pouches……5.6. *Curcuma*

7b. Inflorescence compact or lax, without a terminal plume of barren bracts; bracts not adnate ……...8

8a. Stemless or rarely very short stem; bracts spirally arranged; bract mature from base to top; anther crest, petaloid.…….……...…5.11. *Kaempferia*

8b. Stem usually 15-60 cm; bracts distichously arranged; bracts mature from tip to base; anther crest short or absent….5.3. *Boesenbergia*

3b. Lateral staminodes very small and narrow or absent…….9

9a. Inflorescence arising from rhizomes……....10

10a. Lip ligulate; filament adnate to lip absent.……5.8. *Etlingera*

10b. Lip oblong-obovate or sub orbicular; filament not adnate to lip…....11

11a. Pseudostem stout, ca. upto 5 m tall, connective appendage at the tip, broad, petaloid ……..…5.2. *Amomum*

11b. Pseudostem leafy, ca. 1-2 m tall, connective appendage at the tip, beak like……..…5.14. *Zingiber*

9b. Inflorescence on a terminal spike…….……12

12a. Terrestrial, bracts each subtending 1 flower or a cincinnus of several flowers, anther with connective crest……..13

12b. Terrestrial or epiphyte, bracts each sub-tending 1 sessile flower; anther without connective crest……..…5.13. *Rhynchanthus*

13a. Corolla tube more or less equal to or shorter than the calyx, capsule usually globose, seeds arillated……..…5.1. *Alpinia*

13b. Corolla tube equaling the calyx; capsule globose or oblong; seeds aromatic, aril absent…….….5.7. *Elettaria*

5.1 ALPINIA Roxb., Asiat. Res. 11:350.1810, Fl. Ind. 1:58.1820; Benth. & Hook. f., Gen. Pl. 3:648.1883; L. Wu & K. Larsen in Z.L. Wu & PH. Raven, eds. Fl. China Fl. China. 24: 333-346. 2000.

Rhizomes creeping, thick, fleashy or hard; root stout, root tubers absent. *Pseudostems* many, well developed. Leaves many, rarely 1-4; *leaf blade* oblong or lanceolate. *Inflorescence* a terminal panicle, raceme, or spike, dense or lax, covered by 1-3 sheaths when young; *bracts* (when present) open to base, rarely hooded, each subtending 1 flower or a cincinnus of 2 to many flowers; *bracteoles* open to base or tubular, rarely hooded, sometimes absent. *Calyx* usually tubular, shortly 3-toothed, unilaterally split. *Corolla* cylindric, usually wider than lateral lobes, more or less equal to or shorter than the calyx. *Lateral staminodes* small or absent, adnate to base of labellum. *Labellum* often showy, usually larger than corolla lobes, sometimes inconspicuous, margin variously lobed or entire. *Anther* sessile or with a well developed filament, connective sometimes crest. *Filament* present or absent. *Ovary*

usually trilocular and placentation axile. *Stigma* usually well expanded, sometimes clavate, rarely geni-culate. *Capsule* usually globose, dry or fleshy, indehiscent or irregularly dehiscent. *Seeds* numerous, often angled, arillate.

Key to the species of Mizoram *Alpinia*

1a. Leafy stem more than 3-4 m high, rhizome strongly aromatic…….2

1b. Leafy stem of 1.0 to 2.0 m tall, rhizome slightly aromatic……..……3

2a. Leaves bright green, glabrous beneath; rhizome bitter, corolla whitish with pinky colour at the middle……... 5.1.1. *A. aquatica*

2b. Leaves dark green, densely pubescent below; corolla white……5.1.4. *A. malaccensis*

3a. Staminodes variegated red and yellow, bracteoles oblong, 2-2.5 cm long, completely enclosing the flower bud, flower crowded, yellowish white, corolla white, leaves pubescent beneath……..5.1.2. *A. bracteata*

3b. Staminodes purple, bracteoles lanceolate, 0.5–0.8 cm long, corolla claw green, blade white, striated with red, leaves glabrous……..…5.1.3. *A. galanga*

5.1.1. ***Alpinia aquatica*** Rosc. in Trans. Linn. Soc. 8: 346. 1804; Baker in Hook. f. Fl. Brit. Ind. 6: 256, 1892. **Photoplate-I (A-C)**

Scientific name : *Alpinia aquatica* (Retz.) Roscoe.

Common Name : Aquatic ginger, Aquatic galangal.

Local Name : Tui-Aidu (L. Vanchhawng, 2014).

Locality : Bawngva, Mamit District.

Altitude : 300 - 1000 m.

Habit : Aromatic rhizomatous perennial herb.

Habitat : Occur in tropical semi-evergreen forests.

Botanical Description : *Rhizome* bitter, aromatic. *Leafy stem ca.* 2 m tall; stout, carrying a panicle of small pink flowers at the tip. *Leaves* coriaceous, bright green, denticulate, glabrous beneath; *panicle* narrow, oblong, peduncled; *bract* whitish at base. *Flowers* pinkish white*; calyx* limp tubulose, campanulate, glabrous, tridentate; *corolla* whitish with pink in the middle, upper ovate oblong; *lip* shorter than the corolla segment, reddish pink; *anther* curved, pale yellow. *Fruit* rounded, yellowish green at younger stage, reddish brown at maturity. *Seed* about 5, trietrous.

Phenology : Flowering : June - July.
Fruiting : July - August.

Ecological status : As the botanical name suggests it would grow in water; found on sandy localities near the pond, stream and sea in lowland forest along river margins, ponds, and swampy areas with their rhizomes rooted underwater for a significant period of the year.

Taxonomical status : Rare.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Mikania mikrantha, Mimosa pudica, Erianthus longispattus, Mangifera indica* etc.

Species Examined : Mizoram, Bawngva, Mamit Dist. *L. Vanchhawng & H. Lalramnghinglova* 42856 (MZU).

Distribution : It is native to North eastern part of India, Malaysia, Java and Sumatra.

Uses : The decoction of the Rhizome is taken during the first 3 days after confinement and the decoction of the flowers is taken for cholera.

Remarks : **First reported from Mizoram.**

5.1.2. ***Alpinia bracteata*** Roxb. in Fl. Ind. 1: 63. 1820; Baker in Hook. f. Fl. Brit. Ind. 6: 255. 1892; Haines, Bot. Bih. Or. 1147. 1924; Fischer in Rec. Bot. Surv. India 12(2): 143. 1938; N.P. Singh *et al.* in Fl. Mizoram 1:34-85. 2002; H. Lalram. Ethn. Med. Pl. Mizoram 50. 2003. **Photoplate-I (D-E)**

Scientific name : *Alpinia bracteata* Roxb.

Synonym : *Alpinia calcarata* Roscoe., *Alpinia roxburgii* Sweet.

Common Name : Lesser galangal.

Local Name : Aichal (Mizo), Lapo (Mara)

Locality : Saireptlang, Putlungasih, Khawlek, Mamit, Kawrthah and Ngengpui Wildlife Sanctuary.

Altitude : 500 - 1500m.

Habit : Aromatic rhizomatous herb.

Habitat : Tropical and sub tropical semi evergreen forests.

Botanical Description : *Leafy stem ca.*1 m high. *Leaves* upto 2-3 cm long petiole, 12-50 x 3-12 cm, oblong lanceolate, villous beneath. *Inflorescence* 12-25 cm

long, erect densely flowered, rachis pubescent; *bracteoles* 2-2.5 cm long, oblong, completely enclosing the flower bud, pale green. *Flowers* crowded, shortly pedicelled, yellow; *calyx* 1-1.3 cm long, split on one side; *corolla tube ca.* 8 mm long, lobes 2-2.5 cm long, oblong, white; *staminodes* variegated red and yellow, margin incurved. *Ovary* seceous. *Capsule* large, globose. *Seeds* many in each cell.

Phenology : Flowering : April & May.
Fruiting : July & August.

Ecological status : This taxon is grown on a loamy-clay soil in dense forests.

Taxonomical status : Frequent.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *A. bracteata* is found in associated with *Musa velutina, Phrynium capitatum, Amomum dealbatum, Erianthus longiseosus* etc.

Species Examined : Mizoram, Putlungasih, Lunglei Dist. *L. Vanchhawng & H. Lalramnghinglova* 42842 (MZU).

Distribution : Malaysia, Phillipines, Thailand, Myanmar etc. Wild in India.

Uses : 1) The rhizome is rubbed on grindstone and the paste is mixed with water in which rice has been washed, and given for dyspepsia (Lalramnghinglova, 2003).

2) An equal amount of powdered rhizome with that of *Zingiber officinale* with liitle salt is used for stomatitis.

5.1.3. ***Alpinia galanga*** (Linn.) Willd. Sp. Pl. 1 : 12. 1797; Rosc. In Trans. Linn. Soc. 8: 345. 1807; Baker in Hook. f. Fl. Brit. Ind. 6: 253. 1892; Fischer in Rec. Bot. Surv. Ind. 12(2): 143. 1938; N.P. Singh *et al*. in Fl. Mizoram 1:34-85. 2002.

Photoplate-I (F-G)

Scientific name : *Alpinia galanga* (L.) Willd.

Local Name : Aichal (Mizo).

Common Name : Greater Galangal, Java galangal, Kulanjan (Hindi).

Locality : Thorang W.S., Khawlek, Putlungasih, Lunglei District.

Altitude : 400 - 1200m.

Habit : Tender perennial aromatic herb.

Habitat : Tropical and sub tropical semi evergreen forests.

Botanical Description : *Root stocks* tuberous and slightly aromatic. *Leafy stem* upto a height of 1.5-2 m. *Leaves* oblong-lanceolate, acute, glabrous, green above, paler beneath; *ligule* 7-8 mm acute, hairy outside. *Inflorescence* racemose, tubular flowers bisexual; *bracts* ovate-lanceolate; *bracteoles* lanceolate, 0.5-0.8 cm. *Flowers* greenish white, in dense flowered, 30 cm panicles; *calyx* tubular, irregularly 3-toothed; *corolla lobes* oblong, claw green, blade white, striated with red, broadly elliptic, shortly 2-lobed at the apex; lateral staminodes purple. *Fruit*

the size of the small cherry, orange red. *Seeds* obtusely angular and aromatic.

Phenology : Flowering & Fruiting : April - September.

Ecological status : Galanga demands a sunny or moderate shady place. Soil should be fertile and humid but not swampy. The wild or half-wild varieties occur in old clearings, in thickets and in forests. The plant occurs up to 1200 m above sea-level in the tropics.

Taxonomic status : Frequent.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Lantana camara, Mikania micrantha, Colocasia esculenta, Eupatorium odoratum, Melocanna baccifera;* on fertile soil in roadside and under tropical evergreen forests.

Species Examined : Mizoram, Khawlek, Lunglei Dist. *L. Vanchhawng & H. Lalramnghinglova* 42843 (MZU).

Distribution : The exact origin of galanga is unknown, but oldest reports about its use and existence come from southern China and Java. At present it is cultivated in all S.E. Asian countries and in India, Bangladesh, China and Surinam (Westphal and Jansen, 1989).

Uses : 1) Rheumatism, Bronchial catarrh, bad breath, and ulcers, whooping colds in children, throat infections, to control incontinence, fever and dyspepsia (Chitra and Thoppil, 2008).

2) In India, the rhizomes have many applications in traditional medicines such as for skin diseases, indigestion, colic, dysentery, enlarged spleen, respiratory diseases, mouth and stomach cancer. Rhizomes show antibacterial, anti-fungal, anti-protozoal, and expectorant activities (Warrier *et al.*, 1994). The oil of Greater galangal is valued in perfumery in India.

3) The root has been used in Europe as a spice for over a thousand years; it was probably introduced by Arabian and Greek physicians.

4) It is also used as a body deodorizer and halitosis remedy (Reddy *et al.*, 2011).

5.1.4. ***Alpinia malaccensis*** (Burm. f.) Rosc. in Trans. Linn. Soc. 8: 345. 1807; Roxb. Fl. Ind. 1: 64. 1820; Baker in Hook. f. Fl. Brit. Ind. 6: 255. 1892; Haines, Bot. Bih. Or. 1147. 1924; Fischer in Gamble, Fl. Pres. Madras 1493. 1928; N.P. Singh *et. al*. in Fl. Mizoram 1:34-85. 2002. **Photoplate-I (H-I)**

Scientific name : *Alpinia malaccensis* (Burm. f.) Roscoe.

Local Name : Aipui (Lalramnghinglova, 2014).

Common Name : Malacca Ginger, Forest Galangal (English).

Locality : Bukpui, Kolasib District; Dampa Tiger Reserve, Phuldungsei, Mamit District.

Altitude : 400 - 1000 m.

Habit : A robust perennial rhizomatous herb.

Habitat : Tropical and subtropical evergreen forests.

Botanical Description : *Leafy stem* upto 3-4 m tall and with strong aromatic when bruished. *Leaves* narrowly lance-shaped, 40-90 x 7 cm, acuminate, densely pubescent below; *ligule* entire, upto 1 cm long, hairy. *Inflorescence* racemose, erect or slightly curved, *ca.* 35 cm, bracts absent; *bracteoles* 1.5-2 cm long, caduceus as the flower opens and white. *Flowers* white in color; *calyx* white, 2 cm long, shortly 3-lobed and deeply split unilaterally; *corolla* white, 1 cm, glabrous; *labellum* yellow-orange, broadly ovate, 3-5 cm, narrowing to an emarginate apex; *lateral staminoides* subulate, 5 mm; *filament ca.*1 cm. *Fruit* globose, 2-3 cm across, hairy. *Seed* 3-4 angular, *ca.*5 mm;

Phenology : Flowering : June - August.
Fruiting : August - September.

Ecological status : Commonly found in primary forest and shady rocky at low and medium altitude. *A. malaccensis* prefers rich moist soil in a loamy soil.

Taxonomic status : Rare.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Passiflora nepalensis, Inula cappa, Mikania micrantha, Eupatorium odoratum* etc.

Species examined : Mizoram, Bukpui, Kolasib Dist. *L. Vanchhawng & H. Lalramnghinglova* 42814 (MZU).

Distribution : Eastern India, Southern China, Java, Philippines, Laos, Thailand, Malaysia, Indonesia, Singapore. In India, it is found in N.E. India, Andra Pradesh, Karnataka and Orissa.

Uses : 1) The rhizomes are reported to be used in sores.

2) Stem and rhizome juice is given in stomachache due to acidity or indigestion.

3) A piece of fresh rhizome is taken as anti-emetic.

4) Rhizomes are also employed with other ingredients for respiratory problem in children and to adults for cough.

5.2. **AMOMUM** Roxb., Fl. Indica 1:37. 1820; Baker in Hook. f., Fl. Brit. India 6:233. 1892; C.E.C. Fischer Rec. Bot. Surv. India 9:178. 1921; L. Wu & K. Larsen in Z.L. Wu & PH. Raven, eds. Fl. China 24: 347–356. 2000; M. Sabu, Zingib. & Cost. S. Ind. 78-92. 2006.

Herbaceous leafy stem often very tall. *Root stock* rhizomatous, hard and woody, widely creeping. *Leafy shoot* elongate, 1-5 m high, swollen at the base. *Leaf sheath* long; *ligule* entire or 2-lobed; *leaf blade* usually oblong-lanceolate, oblong, or linear. *Inflorescence* arising from rhizomes, a densely flowered spike or spike like raceme or panicle; *peduncle* short or rather long, clothed with imbricate, scale like sheaths; involucre absent; *bracts* imbricate, persistent, sometimes soon disintegrating; *bracteoles* usually tubular. *Calyx* usually tubular, apex 3-toothed. *Corolla tube* cylindric; lobes oblong or linear-oblong, central one erect, usually wider and more convex than lateral ones. *Lateral staminodes* subulate, small, or absent. *Labellum* conspicuous, usually obovate, broadly concave. *Filament* well developed; anther locules parallel or diverging; Connective appendage at the tip extending

beyond apex of anther, broad, petaloid entire or 3-lobed. *Ovary* trilocular; ovules many per locule, superposed. *Style* filiform; *stigma* usually funnelform, small, ciliate. *Capsule* irregularly dehiscent or indehiscent, smooth, prickly, or winged. *Seeds* many, globose or ovoid.

Key to the species of Mizoram *Amomum*

1a. Pseudostem in a range between 50-100 cm……...2

1b Pseudostem in a range between 100-200 cm……...…3

2a. *Rhizomes* yellowish inside, pale brown outside, *lip* white with a median yellowish band, pink streaks towards base……...5.2.1. *A. aromaticum*

2b. *Rhizomes* pinkish white, *lip* white with a median fleshy orange band, margined with purple dots and yellow central blotch ……..…5.2.7. *A. pauciflorum*

3a. *Corolla tube* equal to or longer than calyx……...4

3b. *Corolla tube* shorter than calyx……...5

4a. *Lip* white, with yellow median band and red streaks at the base and red veins…..5

4b. *Lip* white, median part red from the base to middle and with yellow patch above…….……...…5.2.3. *A. dampuianum*

5a. *Bracts* pale brown, oblanceolate, *corolla tube ca* 2 cm, *lobes* oblong, pinkish white……..5.2.2. *A. corynostachyum*

5b. *Bract* reddish, ovate, *corolla tube* white, *ca.* 2.5 cm; *lobes* lanceolate white……5.2.4. *A. dealbatum*

6a. *Labellum* white with a fleshy orange red, *lamina* oblong-lanceolate….……..…7

6b. *Labellum* pale yellow, yellow at centre, with red spots along margins, *lamina* elliptic to elliptic lanceolate……5.2.6. *A. mizoramense*

7a. *Fruit* ovoid, brownish, *rhizome* branched, slightly aromatic…….5.2.5. *A. jainii*

7b. *Fruit* globose, red-brown, *rhizome* creeping, aromatic only at maturity……...5.2.8. *A. vermanum*

5.2.1. ***Amomum aromaticum*** Roxb. Fl. Indica 1: 45. 1820; Baker in Hook. f. Fl. Brit. Ind. 6: 241. 1892; A.S. Rao & D.M. Verma in Bull. Bot. Surv. Ind. 11: 245. 1971.

Photoplate-II (I)

Scientific name : *Amomum aromaticum* Roxb.

Local Name : Airimtui (Lalramnghinglova & L. Vanchhawng, 2014).

Common Name : Bengal cardamom (English).

Locality : Sialsuk, Aizawl Distict; Thenzawl, Serchhip District.

Altitude : 500 - 1000 m.

Habit : Aromatic rhizomatous herbs.

Habitat : Tropical evergreen and semi evergreen forests.

Botanical Description : *Rhizomes* aromatic, yellowish inside, pale brown outside. *Leafy stems* 30-90 cm high. *Leaves* subsessile, linear lanceolate, 15-30 x 2.7-5 cm, glabrous, aromatic on crushing. *Spikes* clavate, 4-6 cm long; *peduncles* villous; *bracts* oblong, 3-4 x 0.8-1.2 cm. *Flowers* white; *calyx* as long as the bract, villous, pinkish; *corolla tube* equaling the calyx, villous, lobes lanceolate, 2.5-3 x 1-1.5 cm; *lip* obovate, cuneate, 4-4.5 x 2.5-3 cm, white with a median yellowish band and few pink straks towards base, margin crumpled. *Filament ca.* 5 mm long; *anther ca.* 15 mm long, crest, suborbicular, *ca.* 7 mm broad, 3-5 lobed with diplexed tip. *Ovary* villous. *Capsules* ovoid, *ca.* 2.5 cm long, trigonous, fleshy and rugose.

Phenology : Flowering : April - June.
Fruiting : June & July.

Ecological status : The plant is grown in a humid loamy soil in the margin of the forests. It prefers sully or partially shaded.

Taxonomical status : Frequent.

IUCN Category : The taxon has not been assessed against the criteria as described in IUCN, 2014.

Associates : *Amomum dealbatum, Centella asiatica, Rhus semiliata, Hedyotes scandens, Imperata cylindrica,* Bamboo spp.

Species examined : Mizoram, Thenzawl, Serchhip Dist. *L. Vanchhawng & H. Lalramnghinglova* 42821 (MZU).

Distribution : In India, this species is found in Bengal, Bihar, Orissa, Assam, Nagaland, Arunachal Pradesh, Meghalaya, Mizoram and in Southern India. It is native to N.E. India, Bangladesh, Nepal, Bhutan, Vietnam and Myanmar.

Uses : 1) A root extract is obtained by chewing and used for mumps. They are also prescribed as a gargle or mouth-wash or for perlingual administration to treat toothache, gingivitis and parodontosis.

2) Infusion of the leaves of is used by Chakma people for the treatment of anaemia

3) Seeds are eaten raw for digestion.

5.2.2. ***Amomum corynostachyum*** Wall., Pl. Asiat. Rar. 1:48. t. 58. 1830; Baker in Hook. f. Fl. Brit. Ind. 6: 238. 1892; A.S. Rao & D.M. Verma in Bull. Bot. Surv. Ind. 11: 245. 1971; Kumar & Raju in J. Hill. Res. 2: 102. 1989; S. Kumar in Zingib. Sikkim 13-14. 2001. **Photoplate-II (A)**

Scientific name : *Amomum corynostachyum* Wall.

Synonym : *Amomum koenigii* J.F.Gmel.

Local Name : Not available.

Common Name : Long fruit amomum.

Locality : Bukpui, Kolasib District; Dampa Tiger Reserve, Mamit District; Lengteng W.S., Champhai District.

Altitude : 480 - 1300 m.

Habit : A rhizomatous herb.

Habitat : Tropical moist forests

Botanical Description : *Rhizomes* pale yellow inside, reddish brown outside. *Pseudostem* 1-1.5 m; leafy. *Leaves* petioled 30-50 x 5-10 cm, lanceolate, glabrous. *Spikes* 5-56 x 305 cm, globes with 15-30 cm long, villous peduncles; *outer bracts* 2-2.5 x 1 cm long, pale brown; *inner bracts* oblanceolate, obtuse. *Flowers* white; *calyx* 1-1.5 cm; *corolla tube ca* 2 cm, *lobes* oblong, 1-1.5 x 0.5-1 cm, pinkish white; *lip* subrhomboid, cuneate 1.2-1.5 x 0.7 cm, obscurely 3-lobed, white, with yellow median band and red streaks at the base; *staminodes* subulate, *ca* 2 mm long. *Filament ca* 3 mm long; *anther* 6-8 mm long, crest sub-orbicular, 3-4

mm broad, entire wavy white. *Capsules* ellipsoid, faintly many ridged, hairy.

Phenology : Flowering : June & July.
. Fruiting : September & October.

Ecological status : The plant is grown on the hill slope and foot hill area. It is found on a moist fertile soil on Secondary forests, tolerating disturbance.

Taxonomical status : Rare.

IUCN Category : The taxon has been categorized under Least Concerned against the criteria as described in IUCN, 2014.

Associates : *Clerodendrum bracteatum, Costus speciosus, Mikania micrantha, Erianthus longiseosus* etc.

Species examined : Mizoram, Bukpui, Kolasib Dist. *L. Vanchhawng & H. Lalramnghinglova* 42817 (MZU).

Distribution : Bangladesh, Vietnam, N.E. India, Thailand and Myanmar. In India, it is reported in Jaintia Hill of Meghalaya, Sikkim and Mizoram.

Uses : It is used as spice by different tribe of North east India. In Thailand, the whole plant is used to feed captive elephant. No medicinal value has been detected.

5.2.3. ***Amomum dampuianum*** M. Sabu, V.P. Thomas & H. Lalramnghinglova in Nor. J. Bot. 31(5): 561-568. 2013. **Photoplate-III (A-P)**

Scientific name : *Amomum dampuianum* V.P. Thomas & M. Sabu & H. Lalramghinglova

Local Name : Dampui-ai (Lalramnghinglova & L.Vanchhawng, 2014).

Common Name : Not available.

Locality : Dampui Reserve Forests, Mamit Dist.

Altitude : 500 - 900 m.

Habit : Rhizomatous herb.

Habitat : Tropical semi evergreen forests.

Botanical Description : Spreading herb. *Rhizome* stoloniferous, slender, 3-4 mm in diameter, creamy-white inside, covered with scales; scales oblong, *ca* 2 cm long, chartaceous, glabrous. *Leafy shoots* 100-150 cm tall, slender. *Leaves* 8-9 per shoot; sheath *ca* 1 cm wide at base, green, glabrous, with membranous margin; *ligule* 2-4 mm long, coriaceous, glabrous, truncate to emarginate at apex; *petiole* 2.0-3.5 cm long, green, glabrous; *lamina* linear-lanceolate, 33-47 x 2.5-4.5 cm, aromatic when crushed, dark green above, pale beneath, oblique at base, acuminate at apex, glabrous along margin and on both surfaces; *midrib* glabrous; veins appressed above. *Inflorescence ca* 4 cm long, one or two arises from the base of the pseudostem; *spike* 3-4 cm long, obovate-oblong; *peduncle* 0-1 cm long, covered with 4-6 sterile bracts, flowers well exserted from the bracts, 3-4 per inflorescence; *fertile bracts* ovate, *ca*. 2.3-2.2 cm, compactly arranged in two rows, coriaceous, pink, white towards base, puberulous externally, glabrous within, glabrous along margin, mucronate at apex; *bracteole* open to base, ovate, 3.6-4.0 x 1.6-1.9 cm, chartaceous, white, puberulous

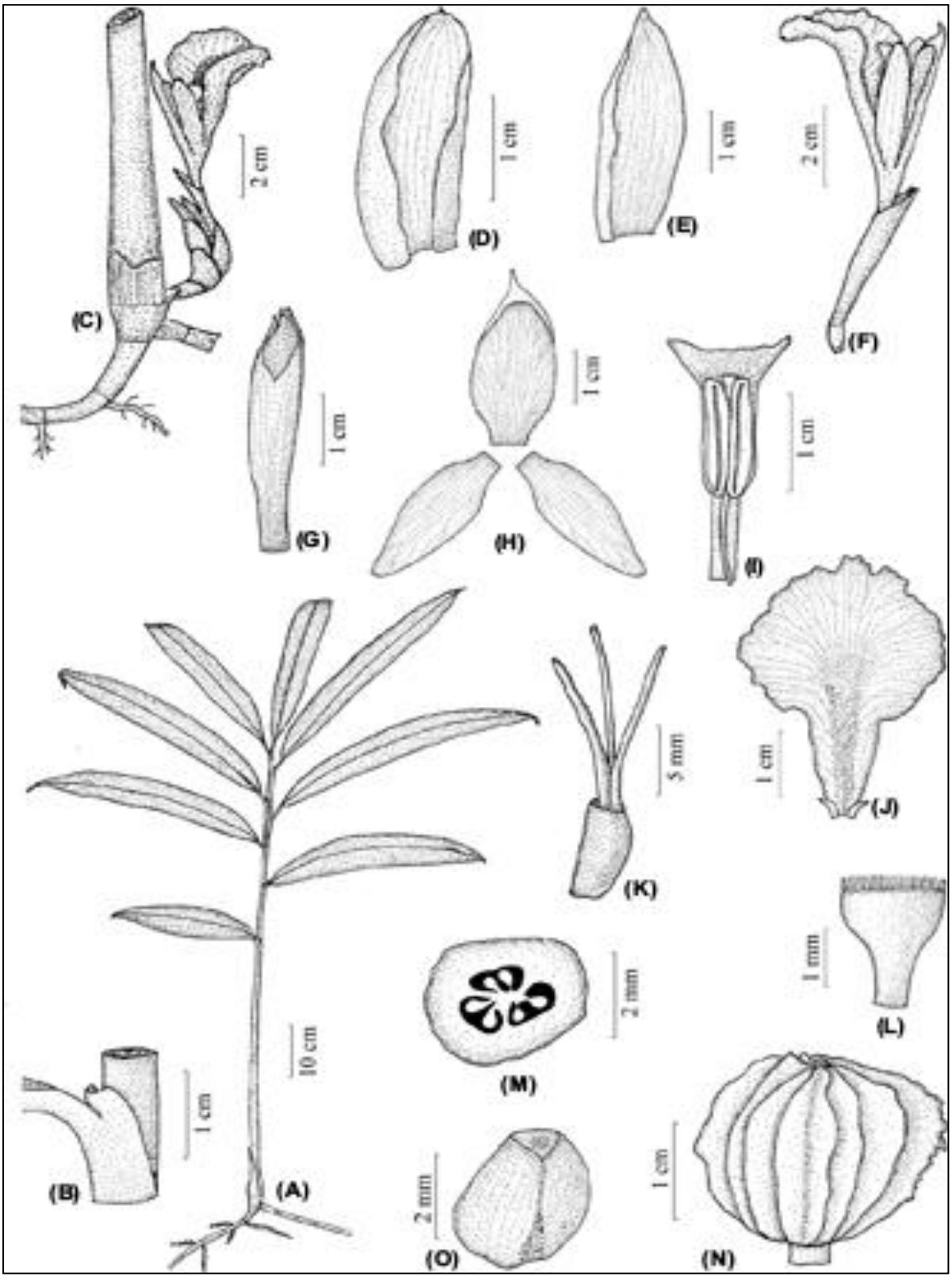


Fig. 5.1: *Amomum dampuianam* sp. nov. (A) habit, (B) ligule, (C) inflorescence, (D) bract, (E) bracteole, (F) flower, (G) calyx, (H) corolla lobes, (I) stamen, (J) labellum, (K) ovary with epigynous glands and style, (L) stigma, (M) cross section of ovary, (N) fruit, (O) seed (sril removed).

towards apex externally, glabrous within and along margin, acute at apex. *Flower* 7.8-9.2 cm long, white; *calyx* 3-lobed, as long as the corolla tube, 3.5-5.4 cm long, 8-9 mm in diameter, white, glabrous externally except for a few hairs near apex, glabrous within, unilaterally split, cleft *ca.* 1.9 cm deep, with small mucro on two lobes; *corolla tube* 3.8-5.4 cm long, *ca*. 4 mm in diameter at apex, white, puberulous externally, villous near apex within; *dorsal corolla lobe* obovate-oblong, 3.3-3.5 x 1.3-1.4 cm, white, glabrous on both surfaces but with margin ciliate towards base, mucronate at apex; *lateral corolla lobes* lanceolate, 3.0-3.4 x 1.0-1.3 cm, white, glabrous on both surfaces, distantly ciliate towards lower margin; *labellum* 4.0-4.2 cm long, apex *ca*. 2.7 cm broad, white, median part red from the base to middle and with yellow patch above, with wavy crumbled margin, clawed to base; claw *ca*. 1.7 cm long, 8 mm broad at its widest point, pubescent from base to middle internally; *lateral staminodes* subulate, *ca*. 3 mm long, slightly flattened, red tinged, densely pubescent near base; *stamen* 2.3-2.6 cm long. *Filament* 0.8-1.0 x 0.2-0.3 cm, white, glabrous abaxially, pubescent adaxially; connective white, pubescent; crest emarginate, *ca*. 3 mm long and 12 mm broad, white, glabrous; *anther* oblong, 1.0-1.2 cm long, cream coloured, glabrous, rounded at base; apex slightly diverging, rounded; dehiscing throughout their length. *Epigynous glands* 2, oblong, 1.2-1.3 cm long, cream coloured, glabrous, acuminate at apex. *Ovary* oblong, 4-5 3 mm, pale pink, glabrous; locules 3; ovules many on axilary placentation; *style* 6.1-6.5 cm long, glabrous; *stigma* cupshaped, *ca* 1.5 mm across; ostiole cilliate, facing upwards.

Infructescence 3-5 cm long, with 2-3 capsules per spike; *peduncle* 3-4 cm long, partly embedded in the ground. *Capsule* globose, winged, *ca.* 2 2 cm, dark maroon, glabrous; calyx not persistent. *Seeds* many, irregularly shaped, 3-4 *ca*. 3 mm, brown, glabrous, arillate; aril white, fully embedding seed.

Phenology : Flowering & Fruiting : March - July.

Ecological status : *Amomum dampuianum* is found growing as undergrowth in the evergreen forest patches. The species is collected only from Dampui Reserve Forest of Mizoram.

Taxonomical status : Critically Endangered according to the 2001 IUCN criteria (CR B1ab (i, ii, iii)) (IUCN 2001). The species is known to exist in Dampui forest and the extent of occurrence is estimated to be less than 100 km^2. In addition, the extent of occurrence continues to decline due to deforestation and widening of roads.

IUCN Category : The taxon has not been assessed against the criteria as described in IUCN, 2014.

Associates : *Costus speciosus, Scleria sumatrensis, Mikania micrantha, Ageratum conyzoides, Osbeckia penducularis, Mussaendra glabra.*

Species examined : Mizoram, Dampui, Mamit Dist. *L. Vanchhawng & H. Lalramnghinglova* 42812 (MZU).

Distribution : Not available.

Uses : Not available.

Remarks : **New species.**

5.2.4. ***Amomum dealbatum*** Roxb., Fl. Ind. 1: 43. 1820; Baker in Hook. f. Fl. Brit. Ind. 6: 239. 1892; A.S. Rao & D.M. Verma in Bull. Bot. Surv. Ind. 14: 135. 1972; S. Kumar in Zingib. Sikkim, 14-16. 2001; N.P. Singh *et. al*. in Fl. Mizoram 1:34-85. 2002; H. Lalram. Ethn. Med. Pl. Mizoram 54. 2003. **Photoplate-II (B-D)**

Scientific name : *Amomum dealbatum* Roxb.

Synonym : *Amomum maxima* Roxb.

Local Name : Aidu (Mizo)

Common Name : Java cardamom.

Locality : Very common throughout Mizoram.

Altitude : 600 - 1200 m.

Habit : A robust perennial herb.

Habitat : Tropical evergreen and semi-evergreen forests.

Botanical Description : A robust ginger with stout stems growing up to 2 m high with leafy stem. *Rhizomes* stout and a dull red in color. *Leaves* large, 10-15 x 60-180 cm, oblong-lanceolate, bright green above, pale and pubescent beneath. *Spikes* subglobose, 3-5 cm in diameter; *peduncle* 2-8 cm; *bracts* reddish, ovate, ca. 2.5 cm. *Flowers* white; *calyx* 3-lobed at apex *ca.* 2.3 cm; *corolla tube* white, *ca.* 2.5 cm; *lobes* white, lanceolate, equaling tube. *Lateral staminodes* subulate, *ca.* 2 mm; *labellum* white with yellow line along center and radiate, red veins,

elliptic, *ca.* 2.5 cm, apex emarginated. *Capsule* purple-green, ellipsoid. *Fruits* globose with 7-9 winged, crenulate, vertical ribs rising from the bulb of rootstock.

Phenology : Flowering : April & May.
Fruiting : May-August.

Ecological status : Grows on loamy and sandy-loam soil in moist shady places. This species is found in the eastern Himalayas and inhabits cool forest areas near mountain streams and damp forest floors. It grows fast and vigorously during the summer monsoon months.

Taxonomic status : Very common.

IUCN Category : The taxon has been categorized under Data Deficient against the criteria as described in IUCN, 2014.

Associates : *Diplazium maximum, Melocana bacifera, Litsea cubeba, Erianthus longiseosus, Homalomena sp.*etc.

Species examined : Mizoram, Hauruang, Lunglei Dist. *L. Vanchhawng & H. Lalramnghinglova* 42857 (MZU).

Distribution : Bangladesh, Laos, Thailand and Vietnam. In India, it is found in tropical forests of eastern Himalayas, Mizoram, Assam, Tripura and Meghalaya.

Uses : 1) Decoction of the root is taken against hypertension.

2) Rhizome or roots are crushed and then fried lightly with mustard oil and is applied to cure joint pains (Sajem and Gosai, 2006).

3) Bark juice is used as antiseptic. (Lalfakzuala *et al,* 2007). Chakma tribe also applied the extracted rhizome to treat abscess (Rahman *et al.*, 2007).

4) The unopened inflorescence is harvested and used to make curries (Lalramnghinglova, 2003).

5.2.5. *Amomum jainii* S. Tripathy & V. Prakash in Nor. J. Bot. 19(5): 609-611. 1999.

Photoplate-II (H)

Scientific name : *Amomum jainii* S. Tripathy & V. Prakash.

Local Name : Not available.

Common Name : Not available.

Locality : Dampa Tiger Reserve, Dampui reserve forest, Mamit District; Bukpui, Kolasib Distrcit; Ngengpui W.S. Lawngtlai District.

Altitude : 700 - 1000 m.

Habit : Rhizomatous perennial herb.

Habitat : Tropical semi evergreen forests.

Botanical Description : *Pseudostem* up to 1.0-1.5 m. *Rhizome* branched just below the soil surface, pinkish outside, whitish inside, slightly aromatic. *Leafy stem* erect, sheath glabrous. *Leaves* petiolate, glabrous; *ligule* acute, glabrous; *lamina* 25-35 x 3-5 cm, oblong-lanceolate, margin pubescent, covered by a wax layer beneath. *Inflorescences* radical, spike subglobose *ca.* 8 cm long, covered with brownish ovate; *bracts* oblong, *ca.* 2.5 x 0.8 cm, convolute, pubescent outside, margin entire;

bracteoles tubular, *ca* 1.8 cm long, bi-lobed, whitish. *Flower* one per bract; *calyx* tubular, *ca.* 0.5 cm long, whitey, 3-lobed; *corolla tube* shorter than calyx, slightly curved, pubescent outside, hairy inside, pinkish; *lobes* oblong rounded, yellowish; *labellum* obovate, concave, white with a fleshy red, hairy towards the base, tip rounded. *Lateral staminoides* subulate *ca.* 2 mm long, hairy. *Stamen* half the length of the labellum. *Filament* broad, *ca.* 5x4 mm, concave; *anther* glabrous, *ca.* 4 mm, yellowish, 3-lobed. *Ovary* pubescent *ca.* 4 x 3 mm, trilocular with axile placenta. *Style* filiform, *ca.* 3 mm long, opening triangular, hairy. *Fruit* ovoid, brownish, *ca.* 2.2 x 1.9 cm, ribbed, hairy.

Phenology : Flowering & Fruiting : April - June.

Ecological status : The plant is found in moist secondary forests as undergrowth, it is generally grown in forest well drained deep loamy soils with abundant humus.

Taxonomical status : Frequent.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : Found growing in association with *Amomum dealbatum* and *Alpinia sp.*

Species examined : Mizoram, Bukpui, Kolasib Dist. *L. Vanchhawng & H. Lalramnghinglova* 42816 (MZU).

Distribution : Native to N.E. Indian states of Assam, Meghalaya, Mizoram.

Uses : The rhizome is locally used as a spice and the extracted juice from the root is used against headache.

Remarks : **First reported from Mizoram.**

5.2.6. ***Amomum mizoramense*** M. Sabu, V.P. Thomas & L. Vanchhawng in Nor. J. Bot. 31(5): 561-568. 2013. **Photoplate-IV (A-N)**

Scientific name : *Amomum mizoramense* M. Sabu, V.P. Thomas & L. Vanchhawng

Local Name : Zoram-ai (Lalramnghinglova & L. Vanchhawng, 2014).

Common Name : Not available.

Locality : Dampui Reserve Forest, Mamit District.

Altitude : 500 - 900 m.

Habit : Rhizomatous herb.

Habitat : Tropical semi evergreen forests.

Botanical Description : Spreading herb. *Rhizome* stoloniferous, slender, 3-5 mm in diameter, creamy-white inside, sheathed with scales; *scales* oblong, 1.5-2.5 cm long, pubescent externally. *Leafy shoots* 50-180 cm tall, slender. *Leaves* 10-20 leaves per shoot; *sheath* 2.0-2.3 cm wide at base, green, with ciliate margin, rounded at apex, pubescent externally, glabrous within; *ligule* truncate to emarginate at apex, 2-3 mm long, coriaceous, green, glabrous; *petiole* 2-5 mm long, green, glabrous; lamina elliptic to elliptic-lanceolate, 18-25 x 3.0-5.2 cm, cuneate at base, wavy along margin, at apex with a to 4 cm long acumen, curled,

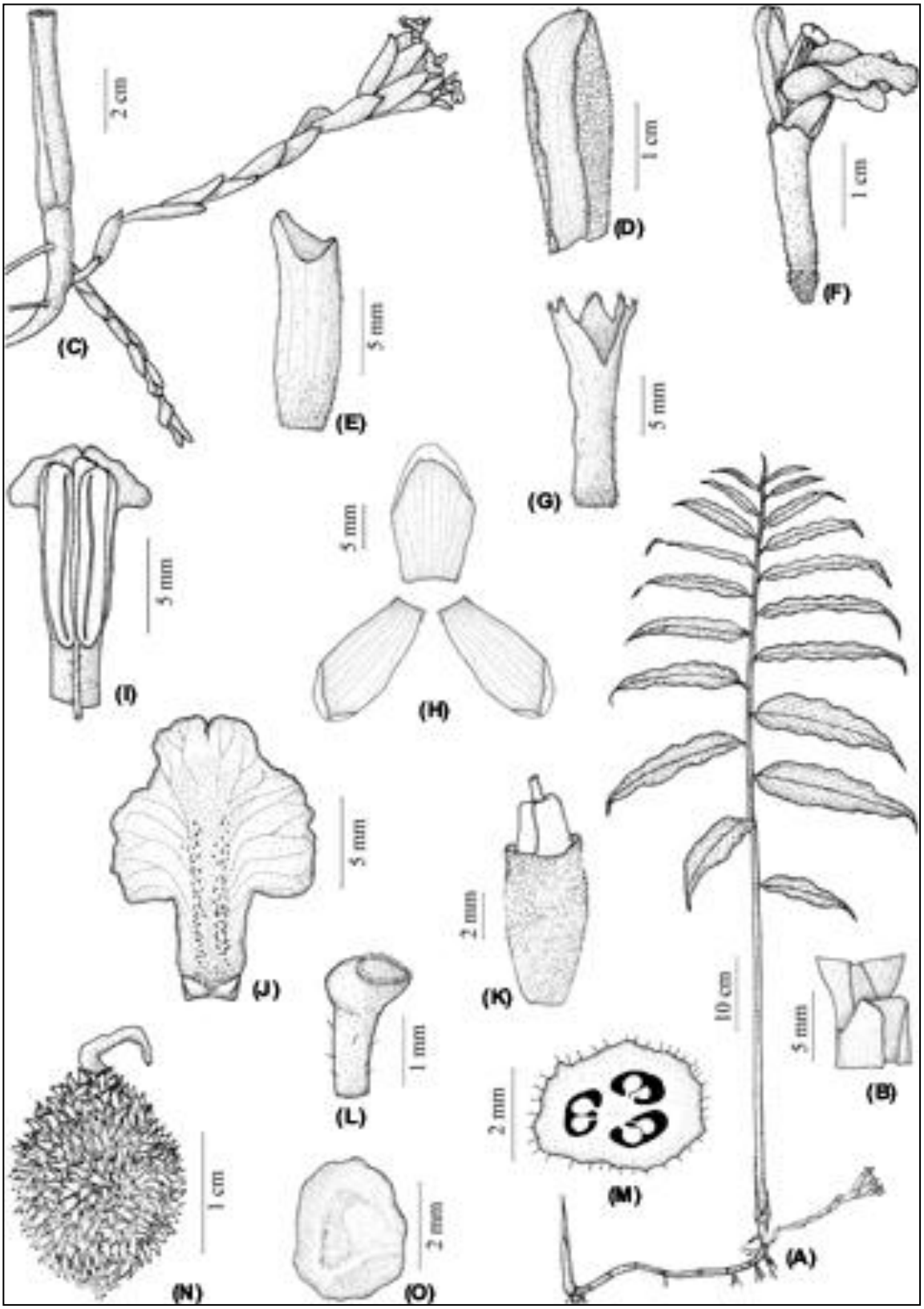


Fig. 5.2: *Amomum mizoramense* sp. nov. (A) habit, (B) ligule, (C) inflorescence, (D) bract, (E) bracteole, (F) flower, (G) calyx, (H) corolla lobes, (I) stamen, (J) labellum, (K) ovary with epigynous glands and style, (L) stigma, (M) cross section of ovary, (N) fruit, (O) seed (aril removed).

glabrous on both surfaces; *midrib* glabrous; veins appressed above. *Inflorescence* 6-13 cm long, many flowered, arises from the rhizome under soil; *spike* 2-3 cm long; *peduncle* 4.0-10.5 cm long; *fertile bract* obovate, 2.5-3.0 x 0.6-1.8 cm, chartaceous, pale brown, pubescent externally, glabrous within, glabrous along margin, minutely mucronate at apex; *bracteole* tubular, 2-lipped, 1.2-1.4 x 0.4 cm, membranous, pale pink, with one lip longer than other, pubescent externally, densely towards the base, sparsely towards apex, glabrous within, rounded at apex. *Flower* 3.2-3.5 cm long, white to pale yellow; *calyx* 3-lobed, 1.7-2.0 cm long, *ca*. 4 mm in diameter, white, membranous, sparsely pubescent near apex and externally, glabrous within, with mucro on two lobes; mucro 1.0-1.5 mm long; *corolla tube* 1.3-1.5 long, 3-4 mm diameter at apex, pubescent externally, densely pubescent towards apex within and glabrous towards base; *dorsal corolla lobe* obovate, 1.5-1.7 x 0.7-0.8 cm, white, glabrous on both surfaces, with upper margins folded to form a hood, emucronate, sparsely ciliate along margin; *lateral corolla lobes* oblanceolate, 1.5-1.7 x 0.6-0.7 cm, glabrous on both surfaces, with lower margin sparsely ciliate and apex folded in one side. *Labellum* obovate, tri-lobed; median lobe slightly cleft, 1.3-1.9 cm long, pale yellow, yellow at centre, with red spots along margins of yellow centre, with wavy margin, clawed to base; claw 5-7 mm long, 4 mm broad base clawed, densely pubescent near base adaxially. *Lateral staminodes* highly reduced. *Stamen* 1.3-1.4 cm long; *filament* 3-4 mm, white, glabrous, rarely puberulous; connective white, glabrous; crest with a wedgeshaped cleft at centre, which often proceeds to base and split

the crest into two lobes, 6-7 *ca*. 1 mm, pale yellow, glabrous, with wavy margins; *anther* thecae oblong, *ca*. 9 1 mm, pale yellow, with base and apex rounded, puberulous; dehiscing throughout their length. *Epigynous glands* 2, oblong, *ca*. 2 mm long, creamy-yellow, minutely lobed at apex. *Ovary* oblong, 6-7 *ca*. 3 mm, pubescent externally; locules 3; *ovules* many on axilary placentation; *style* 2.4-2.6 cm long, densely pubescent towards apex and glabrous towards base; stigma cup-shaped, *ca*. 1 cm across, white, ostiole ciliate, facing sub-lateral. *Infructescence* 11-14 cm long, with 5-7 capsules per spike. *Capsule* sphaerical, densely echinate, 1.8-2.0 x 1.5-1.8 cm, red, pubescent; *calyx* persistent; pedicel *ca*. 5 cm long. *Seeds* many, irregularly shaped, 3-4 x 2-3 mm, dark brown, glabrous, arillate; aril white, fully embedding seed.

Phenology : Flowering & Fruiting : March - July.

Ecological status : *Amomum mizoramense* grows as undergrowth in the evergreen forests in Lunglei and Mamit districts of Mizoram. It is known to exist in three localities, and the area of occupancy is estimated to be less than 500 km^2. Habitat loss is at risk due to various anthropogenic activities.

Taxonomical status : *Amomum mizoramense* is considered to be 'Endangered' according to the 2001 IUCN criteria (EN B2ab (i, ii, iii)) (IUCN 2001).

Associates : *Mikania micrantha, Amomum dealbatum, Callicarpa arborea, Melocanna baccifera.*

Species examined : Mizoram, Dampui, Mamit Dist. *L. Vanchhawng & H. Lalramnghinglova* 42812 (MZU).

Distribution : Mizoram, India.

Uses : Not available.

Remarks : **New species.**

5.2.7. ***Amomum pauciflorum*** Baker in Hook. f. Fl. Brit. Ind. 6: 238. 1892; A.S. Rao & D.M. Verma in Bull. Bot. Surv. Ind. 11: 245. 1971.

Scientific name : *Amomum pauciflorum* Baker

Local Name : Not available.

Common Name : Not available.

Locality : Dampa Tiger Reserve, Mamit District.

Altitude : 800 - 1000 m.

Habit : Perennial rhizomatous herbs.

Habitat : Tropical and subtropical forests.

Botanical Description : *Rhizomes* 1-2 m long, *ca.* 6 mm thick, pinkish white. *Stem ca*. 60 cm high; *Leaves* oblanceolate, 29-31 x 5-6 cm, sericeous beneath; *petiole* 2-4 cm long. *Spikes* several, distant, bearing 6-7 successively opening flowers on a very short rhachis appearing as though in cluster; *peduncles ca.* 3.5 cm long; *bracts* lanceolate, upto 7.5 x 1.2 cm, white with a reddish cusp at the tip, 1-flowered. *Flowers* white; *calyx* 3-6

cm long, split on one side; *corolla lobes* 3.5-4.5 cm long; staminodes subulate, *ca.* 3 mm long, pinkish, hairy; *lip* 4.8-5.2 x 3.5-4 cm, white with a fleshy orange median band towards base, margined with purple dots and yellow central blotch, margins crumpled, apex notched. *Filament* 5-8 mm long, reddish; *anther ca.* 15 mm long,crest transversely oblong, faintly 3-lobed, sides involute, tip revolute, 4-5 mm high, 6-7 mm broad, white. *Fruits* (young) white, hairy, ribbled.

Phenology : Flowering : June & July.
Fruiting : August & September.

Ecological status : Grown on moist shady places in the margins of tropical forest with high humas content.

Taxonomical status : Rare.

IUCN Category : The taxon has not been assessed against the criteria as described in IUCN, 2014.

Associates : *Costus speciosus, Mikania micrantha, Amomum dealbatum, Callicarpa arborea, Rhus semiliata, Gmelina arborea,* Bamboo sp.

Species examined : Mizoram, Dampui, Mamit Dist. *L. Vanchhawng & H. Lalramnghinglova* 42809 (MZU).

Distribution : In India, the species is found in Meghalaya and Mizoram. It is endemic to Sout East Asian countries like Bangladesh, Myanmar and Thailand.

Uses : There are no reports with regard to the utilization of this plant for medicinal purpose as well as food.

Remarks : **First reported from Mizoram.**

5.2.8. ***Amomum vermanum*** S.Tripathy & V. Prakash in Edin. J. Bot. 57: 257. 2000.

Photoplate-II (J-K)

Scientific name : *Amomum vermanum* S.Tripathy & V. Prakash.

Local Name : Not available.

Common Name : Not available.

Locality : Lengteng W.S., Champhai Dististrict; Darlawn forests, Aizawl District.

Altitude : 800 - 1300 m.

Habit : Rhizomatous perennial herb.

Habitat : Tropical and subtropical semi evergreen forest.

Botanical Description : The plant is *ca.*1.5m tall. *Rhizome* creeping, pinkish outside, creamish inside, aromatic at maturity. *Leaves* petiolate, oblong-oblanceolate, 45-140 x 6-13cm, glabrous, margins entire; *ligule* coriaceous, 1cm long. *Inflorescence* radical, spike sub-globose, *ca.* 8×5cm; *bract ca.* 2.3 x 1.0cm, obovate-acute, margins brown, ciliate towards the tip; *bracteole* tubular *ca.*1.5cm long, bilobed. *Flower* one per bract, 5-8 open at one time, *ca*. 3cm long, white; *calyx* tubular, *ca.* 2cm long, 3-lobed, pubescent; *corolla-tube* shorter than the calyx, slightly curved, pubescent outside, entirely glabrous inside; *labellum*

sub-rhomboid, *ca.* 1.5 x 1.0cm, white with fleshy orange, tip emarginate, orange-yellow, margins entire. *Lateral staminodes* subulate, *ca.* 2mm long. *Filament* 0.5cm long; yellow. *Ovary ca.* 0.5cm long, villous, trilocular with axile placentation. *Style* filiform *ca.* 2.0cm long, ciliate. *Fruit* globose, red-brown, pubescent *ca.*1cm across, covered lower-half with persistent bracteole. *Seed* brownish with white aril.

Phenology : Flowering & Fruiting : April - June.

Ecological status : Grown on a humid loamy soil in shady places, in margins of tropical moist forest.

Taxonomic status : Frequent.

IUCN Category : The taxon has not been assessed against the criteria as described in IUCN, 2014.

Associates : *Hedychium spicatum, Inula cappa, Costus speclosus, Mikania micrantha, Begonia inflate* etc.

Species examined : Mizoram, Darlawn, Aizawl Dist. *L. Vanchhawng & H. Lalramnghinglova* 42846(MZU).

Distribution : North East India states of Assam, Meghalaya, Mizoram, Tripura.

Uses : Fruit is used in the form of spices and raw food (Tripathi and Prakash, 2000).

Remarks : **First reported from Mizoram.**

5.3. BOESENBERGIA Kuntze, Rev. Gen. Pl., 685. 1891; A.S. Rao & D.M. Verma, Bull. Bot. Surv. India 14:123. 1972; T.L. Wu & K. Larsen in Z.L. Wu & P.H. Raven, eds. Fl. China 24: 367-368. 2000.

Rhizomes very small, tuberous or elongate, roots many, cylindrical, fleshy, white inside. *Leafy shoot* 15-60 cm tall. *Leaves* basal or cauline, petiolate; *ligule* 2-lobed; *leaf blade* ovate, oblong, or lanceolate. *Inflorescence*s terminal on pseudostems or on separate shoots arising from rhizomes; *bracts* relatively long and narrow, distichously arranged, mature from tip to base; boat-shaped, 1-bracteole and 1 flower. *Flowers* form at the base of the plant; *calyx* tubular, short; *corolla tube* exserted from calyx, slender; *lobes* subequal, spreading. *Lateral staminodes* petaloid, usually wider than corolla lobes. *Labellum* obovate or broadly oblong, larger than corolla lobes and lateral staminodes, strongly concave, base narrow, grooved, margin crisped, apex entire or 2-cleft. *Filament* erect; *anther* crest short or absent, locules parallel, dehiscing by slits or apical pores, base without spur, connective with or without appendage. *Ovary* 3-loculed or incompletely so, axile placentation. *Capsule* oblong, 3-valved. *Seeds* black; aril laciniate.

Key to the species of Mizoram *Boesenbergia*

1a. Stemless herbs, inflorescences on separate shoots arising from rhizomes in radical spikes, lateral staminodes equaling corolla lobes…….5.3.1. *B. longiflora*

1b. Stem short, completely included within leaf sheaths, inflorescence included within the leaf sheath, equal to or shorter than the corolla lobe....5.3.2. *B. tiliaefolia*

5.3.1. ***Boesenbergia longiflora*** (Wall.) O. Kuntze, Rev. Gen. Pl. 685. 1891; Baker in Hook. f., Fl. Brit. Ind. 6: 217. 1890; Haines, Bot. Bih. Or. 1136. 1924; T.L. Wu & K. Larsen in Z.L. Wu & P.H. Raven, eds. Fl. China 24: 367-368. 2000.

Photoplate-II (L-M)

Scientific name : *Boesenbergia longiflora* (Wallich) Kuntze,

Synonym : *Curcumorpha longiflora* (Wall.)

Local Name : Ailaidum (Mizo).

Common Name : Rosy orchid ginger.

Locality : Dampui Reserve Forest, Mamit District.

Altitude :800 - 1200 m.

Habit : Leafy rhizomatous herb.

Habitat : Tropical evergreen forests.

Botanical Description : Stemless herbs, with tufted, cylindric fibrous robust roots; Plants up to 50-60 cm tall. *Leaves* ovate, green, base cordate, apex cuspidate, distichous, 30-40 x 10-12 cm, oblong, acute, long petioled, tinged with purple beneath; *petiole ca*. 30 cm long. *Inflorescences* on separate shoots arising from rhizomes in radical spikes; *bracts* ovate, 2-4 cm, villous, apex acuminate. *Flowers* 3-6, bluish purple; *calyx* shorter than the bract, 1-2 cm; *corolla tube* 4 cm, very slender, much longer than the bracts; *lobes* lanceolate, 2.2-2.5 cm x 5-6 mm. *Lateral staminodes* white, spathulate, ovate, equaling corolla lobes. *Lip* tinged with red, cuneate, crisped on the incurved margin. *Labellum* obovate-

cuneate, *ca.* 3 x 1.8-2 cm. *Filament* very short; *anther ca.* 1 cm, connective broad, appendage linear; *stigma* thickened. *Capsule* long. *Seeds* ovoid with a small basal aril.

Phenology . : Flowering : June & August.
Fruiting : August & September.

Ecological status : This taxon can be found on humid moist soil in the forest floor tropical evergreen forests.

Taxonomic status : Rare.

IUCN Category : The taxon has not been assessed against the criteria as described in IUCN, 2014.

Associates : *Amomum dealbatum, Callicarpa arborea, Rhus semialata, Piper diffusum* etc.

Species examined : Mizoram, Dampui, Mamit Dist. *L. Vanchhawng & H. Lalramnghinglova* 42818(MZU).

Distribution : The species is found in Eastern Himalayas, Laos, Myanmar, Thailand and Chittagong Hill tract of Bangladesh generally at the altitude of 1100-1900m.

Uses : 1) The rhizomes of Boesenbergia longiflora have been traditionally used in treatment of inflammatory bowel disease, ulcerative colitis, aphthous ulcer and abscess (Sudsai *et al*., 2014).

2) The species is cultivated in S.E. Asian countries for ornaments.

5.3.2. ***Boesenbergia tiliaefolia*** (Baker) Kuntz., Rev. Gen. Pl. 685. 1891; Schlechter in Fedde, report 12: 317. 1913; Loesener in Engler & Prantl, Nat. Pflan. 2(5a): 568. 1930; Ramamoorthy in C.J. Saldhanha & Nicolson, Fl. Hassan Dist. 766. 1976; Mangalay & Swarupanandan, Bull. Bot. Surv. Ind. 23(3&4): 236. 1981; M. Sabu, Zingib. & Costa. South Ind. 124-125. 2006.

Photoplate-II (N-P)

Scientific name : *Boesenbergia tiliaefolia* (Baker) Kuntz.

Local Name : Not available.

Common Name : Not available.

Locality : Cultivated in Durtlang private gardens, Horticulture farm, Chite.

Altitude : 800 - 1100 m.

Habit : Rhizomatous perennial small herb.

Habitat : Tropical semi-evergreen forests.

Botanical Description : *Rhizome* small, fleshy, perennial, purple black in colour. *Leafy shoot* 15-30 cm tall; *stem* short, completely included within leaf sheaths. *Leaves* 3-5, distichous, *petiole* 2-4 cm, *lamina* 8-20 x 6-10 cm, elliptic, tip acute, glabrous, tip hairy; *ligule ca.* 5 mm, membranous,glabrous. *Inflorescence* subsessile, 6-8 cm long included within the leaf sheath; *bracts* oblong-lanceolate, green, sparsely hairy, each subtended as a single flower; *bracteoles* equal to the bracts, narrower, tip hairy. *Flowers* small pinkish white, arise from the base of the stem; *calyx* truncate, 0.5-1.0 cm, bifid; *corolla tube* equal to the

bracts. *Lobes* linear-oblong, 1.5-2.0 cm, white to light pink. *Labellum* 2.5-3.0 x 2 cm, apex slightly bilobed, white with pink spot in the centre. *Lateral staminodes* 1.2 x 0.6 cm, white. *Filament ca.* 1 cm long; *anther* 4 mm, puberulent on top. *Ovary* 2mm long, glabrous, tricarpellary, unilocular. *Ovules* 6, attached to the posterior septum in the lower part of the ovary. *Capsule* 2-4 seeds, dehiscent. *Seeds* brown to black, minutely hairy, aril lacerate.

Phenology : Flowering & Fruiting : August - November.

Ecological status : The plant is forest undergrowth in tropical forests at high altitude. It thrives well in humus rich soil with adequate supply of water.

Taxonomical status : Rare.

IUCN Category : The taxon has not been assessed against the criteria as described in IUCN, 2014.

Associates : Cultivated alongwith *Curcuma longa and Zingiber officinale.*

Species examined : Mizoram, Durtlang Aizawl, Aizawl Dist. *L. Vanchhawng & H. Lalramnghinglova* 42886(MZU).

Distribution : In India, it is report only from Meghalaya, Kerala and Mizoram.

Uses : In Mizoram, the rhizome is used for dysentery, Cholera. The infusion of the whole plant is also suggested for jaundice and liver problems.

Remarks : **First reported from Mizoram**. The plant is not found in wild.

5.4. CAULOKAEMPFERIA K. Larsen in Saert. Bot. Tidsskr. 60:170. 1964; A.S. Rao & D.M. Verma in Bull. Bot. Surv. India 4:125. 1972; T.L. Wu & K. Larsen in Z.L. Wu & P.H. Raven, eds. Fl. China 24: 377. 2000.

Herbs perennial. *Pseudostems* erect, leafy. *Leaves* sessile or petiolate; *ligule* 2-lobed, small. *Inflorescences* terminal; bracts 1-10, distichous, lanceolate, 1-4-flowered, margin free to base; *bracteoles* absent in species with 1-flowered bracts. *Flowers* yellow or whitish; *calyx* tubular, not deeply split on one side, apex often 2 or 3-toothed; *corolla tube* long, narrow, widened at mouth; *lobes* 3, central one slightly longer and wider than lateral ones. *Lateral staminodes* petaloid, large. *Labellum* orbicular or broadly ovate, large, concave, apex entire or 2-lobed. *Filament* very short or absent, borne on corolla tube. *Ovary* 3-loculed.

About 3 species in India; 1 species in Mizoram.

5.4.1. *Caulokaemferia linearis* (Wall.) K. Larsen in Saert. Bot. Tidsskr. 60: 170.1964; Rao & Verma in Bull. Bot. Surv. Ind. 14: 125. 1972; N.P. Singh *et. al*. in Fl. Mizoram 1:34-85. 2002. H. Lalram. Ethn. Med. Pl. Mizoram 98. 2003.

Photoplate-V (A)

Scientific name : *Caulokaemferia linearis* (Wall.) K.Larsen

Local Name : Lung-ai-thing (Lalramnghinglova, 2003)

Common Name : Da-bao-jiang-shu (China). English name not available.

Locality : Ngengpui Wildlife Sanctuary, Lawngtlai Dist, Thorang Wildlife Sanctuary, Lunglei Dist., Tuichawng, Fangfarlui and Nghalimlui and tropical forests of south western part of Mizoram.

Altitude : 300 - 800 m.

Habit : Terrestrial or epiphytic rhizomatous herb.

Habitat : Grows on rocks along river banks.

Botanical Description : A gregarious annual herb. *Rhizomes* very small and deciduous in winter. *Stem* 10-20 cm; roots slender; tips swollen. *Leaves* deep green, sessile, linear acuminate, coriaceous, 5-10 cm long, puberulous beneath. *Inflorescence* is terminal, each flower covered by a bract; *bracts* 2, lanceolate, green. *Flowers* white, 1 or 2-flowers spike; *lip* 1-2 cm, equally broad, white with yellow base. *Fruits ca.* 2 cm long.

Around November as winter sets in the stems dry up and the rhizomes remain dormant throughout winter.

Phenology : Flowering : April - June.
. Fruiting : July - August.

Ecological status : This species is found in the eastern Himalayas and inhabits cool forest areas near mountain streams and damp forest floors growing along with other weeds. Also found growing on crevices of large boulders by mountain streams in humus collected in the crevices. It is growing fast and vigorously during the summer monsoon months.

Taxonomic status : Rare, Infrequent.

IUCN Category : The taxon has not been assessed against the criteria as described in IUCN, 2014.

Associates : Gregariously grow on the walls of moist rocks amongst mosses.

Species examined : Mizoram, Durtlang Tuichawng, Lunglei Dist. *L. Vanchhawng & H. Lalramnghinglova* 42851(MZU).

Distribution : Native to China, Bangladesh, Eastern Himalayas. In India, it is found in Assam and Meghalaya; common on rocks of river banks in tropical south western part of Mizoram.

Uses : *Chakma tribe* used to apply the crushed leaves on the head in vertigo (Lalramnghinglova, 2003).

5.5. CAUTLEYA (Benth.) Royle ex Hook. in Bot. Mag. 114: t. 6991. 1888; Wu & Larsen, Fl. China 24: 366-367. 2000.

Rhizomes very short; roots fascicled, thick, fleshy. *Leaves* petiolate ligulate, oblong or lanceolate. *Inflorescence* a terminal spike; bracts colored, persistent, 1-flowered. *Flowers* yellow or orange; *calyx* long tubular, split on 1 side; *corolla tube* equaling or longer than calyx. *Lateral staminodes* erect, petaloid. *Labellum* reflexed, broadly cuneate, apex emarginated. *Filament* erect, short; *anther* locules linear, contiguous. *Style* linear; stigma turbinate, margin ciliate. *Ovary* globose, 3-loculed. *Ovules* numerous per locule; placentation axile. *Capsule* globose, soon dehiscing to base with recurved valves exposing seeds on a columnar mass. *Seeds* red, gray, or black, angled.

Key to the species of India *Caytleya*

1a. Bracts red, longer than calyx; leaves petiolate ……*C. spicata*

1b. Bracts green, shorter than calyx, purple red; leave, sessile, seeds angular exarillate…….. ……...…… 2

2a. Spikes 2–10-flowered, seeds black ....…….…… . *C. gracilis*

2b. Spikes 15–20- or more flowered, yellow…….....… *C. cathcartii*

5.5.1. ***Cautleya gracilis*** (Smith) Dandy in J. Bot. 70:328, 1954; Rao & Verma in Bull. Bot. Surv. Ind. 14: 121. 1972. *Roscoea gracilis* J.E. Smith in Trans. Linn. Soc. 13:60. 1822; T.L. Wu & K. Larsen in Z.L. Wu & PH. Raven, eds. Fl. China 24: 366. 2000; N.P. Singh *et. al*. in Fl. Mizoram 1:34-85. 2002; H. Lalram. Ethn. Med. Pl. Mizoram 99. 2003. **Photoplate-V (B-C)**

Scientific name : *Cautleya gracilis* (Smith) Dandy.

Local Name : Pa-le (Bru)

Common Name : Hardy ginger (English).

Locality : Perhsang, Tuipuibari, West Phulpui, Murlen National Park.

Altitude : 500 - 1500 m.

Habit : Rhizomatous terrestrial or epiphytic herb.

Habitat : Temperate and Sub tropical semi evergreen forest.

Botanical Description : *Pseudostems* 25-80 cm, slender. *Leaves* 4-6, sessile; *leaf sheath* greenish white or with purple-red spot; *ligule* membranous, *ca.* 2 mm, apex rounded; *leaf blade* abaxially green, usually purple or green, lanceolate or oblong-lanceolate, 6-18 x 1.5-6 cm, glabrous, base rounded or attenuate, apex caudate-acuminate. *Spikes* laxly 2-10-flowered; *rachis* red, slightly flexuous; *bracts* green, lanceolate, shorter than calyx. *Flowers* small, deep red alternately arranged; *calyx* purple-red, 1.5-2 cm, apex minutely toothed; *corolla tube* slightly exserted from calyx; *lobes* bright yellow, lanceolate, 1.5–2 cm. *Labellum* obovate, apically 2-cleft to below middle. *Filament* curved,

ca. 2 cm. *Ovary* glabrous. *Capsule* red, globose, *ca.* 8 mm in diam. *Seeds* black, angled; aril absent.

Phenology . : Flowering : June & July.
Fruiting : August & September.

Ecological status : The plants gown well in half shaded, moist, humus rich and well drained soil of tropical rain forests. In the wild, *Cautleya gracilis* is found growing on trees as epiphyte or on the ground of steep rocky locations in cool, moist forests at high elevation.

Taxonomic status : Rare.

IUCN Category : The taxon has not been assessed against the criteria as described in IUCN, 2014.

Associates : Intercropped with *Trevesia palmate, Cajanus cajan, Solanum indicum* etc. in gardens of shady places.

Species examined : Mizoram, Murlen National Park, Champhai Dist. *L. Vanchhawng & H. Lalramnghinglova* 42877(MZU).

Distribution : The species is most widely distributed, occurring in the Himalayas of north India, Bhutan and Nepal, through mountainous regions in Burma, Yunnan (China) and Thailand to North Vietnam. In India, it is found in Kashmir, Assam, Meghalaya, Sikkim and Manipur. In Mizoram, the taxon is found in both wild and cultivated; particularly by the *Brus* in the western part of Mizoram.

Uses : 1) Infusion of rhizome is taken for flatulence, colic and hepatomegaly @ tablespoonful (10ml) twice daily.

2) Rhizome is eaten raw to relieve colic and hotness in the stomach (Lalramnghinglova, 2003).

5.6. CURCUMA Linn., Sp. Pl. 2.1753, Gen. Pl. ed. 5. 3: 1754; Roxb., Asiat. Res. 11:338. 1810, Fl. Indica 1:20. 1820; T.L. Wu & K. Larsen in Z.L. Wu & PH. Raven, eds. Fl. China 24: 359-362. 2000.

Rhizomes branched, fleshy, aromatic. *Leaves* basal, broadly lanceolate or oblong. *Inflorescence* compact with a terminal plume of barren bracts, on pseudostems or on separate shoots arising from; *bracts* obovate,-oblong, concave, laterally, partially adnate forming a cup like structure containing flower;*bracteoles* scarious. *Flowers* arising from the rhizome at the base of the plant; *calyx* usually shortly tubular, split on one side, cylindric; *corolla* funnelform; *lobes* ovate or oblong, subequal or central lobe longer, apex mucronate. *Lateral staminodes* petaloid, broad, basally adnate to filament and labellum. *Labellum* with a thickened, central portion and thinner, lateral lobes overlapping with lateral staminodes. *Filament* short, broad; *anther* versatile, base usually spurred; connective appendage absent. *Ovary* trilocular. *Capsule* ellipsoid, 3-valved, dehiscent. *Seeds* ovoid or oblong, usually arillate.

Key to the species of Mizoram *Curcuma*

1a. Leaves with a purple patch along the midrib…….. ……...…….2

1b. Leaves without a purple patch along the midrib……..3

2a. Rhizome blue in the centre and merging towards grey ……..……6

2b. Rhizome brownish outside, pale yellow inside…….……5.6.7. *C. zeodaria*

3a. Rhizomes with the smell of green mango…..……..5.6.2. *C. amada*

3b. Rhizomes without the smell of green mango……..……4

4a. Large herbs with 1 to 2 m high, rhizomes with pale yellow inside……...……..5

4b. Medium sized herb less than 1 m tall, rhizomes with orange-yellow inside ……5.6.5. *C. longa*

5a. Rhizomes faintly aromatic, corolla pinkish white……..…5.6.3. *C. aromatica*

5b. Rhizomes aromatic, taste very bitter, corolla light orange….5.6.6. *C. rubrobracteata*

6a. Corolla tube pale yellow…….……..…5.6.4. *C. caesia*

6b. Corolla tube pink color ……..……5.6.1. *C. aeruginosa*

5.6.1. ***Curcuma aeruginosa*** Roxb. in Asiat. Res. 11: 335. 1810, Fl. Indica 1: 27. 1820; Rosc. Monandr. Pl. t. 106. 1828; Baker in Hook. f. Fl. Brit. Ind. 6: 2012. 1890; K. Schum. in Englar, Pflan. 4(46): 112. 1904; M. Sabu, Zingib. Cost. South Ind. 132 & 137. 2006. **Photoplate-V (G-H)**

Scientific name : *Curcuma aeruginosa* Roxb.

Local Name : Not available.

Common Name : Arrowroot wild, East Indian arrowroot (English).

Locality : Pawlrang village, on the way to Lengteng Wildlife sanctuary.

Altitude : 1000 - 1300 m.

Habit : Rhizomatous herb.

Habitat : Sub-tropical semi evergreen forest.

Botanical Description : Plant 70-120 cm. *Pseudostem* 30-35 cm. *Rhizome* blue in the centre, merging towards grey, aromatic. *Leaves* distichous, 30-40 x 10-12 cm, oblong-lanceolate, tip acute, base acuminate, glabrous purple or reddish-brown patch along the sides of the distal half of the mid rib on upper side only, fading at maturity; *petiole* as long as lamina. *Inflorescence* lateral, 25-30 cm, peduncle 12-18 cm; *bracts* large, pink to violet, lower ones streaked green; *bracteoles* 3.5 x 2.5 cm, white with a median light green patch. *Flowers* 4.5-5 cm, equal to or slightly shorter than the bracts; *calyx* 1 cm, truncate, 3-lobed at apex, split on one side; *corolla tube* 3-3.3 cm, pink, lobes unequal. *Labellum* 1.5-1.7 x 1.8 cm tip emarginated, yellow with a deep yellow median band. *Lateral staminodes* 1.5 x 1 cm, yellow. *Ovary* 5 mm, trilocular, with many ovules. *Style* long, filiform. *Stigma* bilipped, slightly exserted above the anther lobes.

Phenology : Flowering : May - July.
Fruiting : August & September.

Ecological status : Found in a moist well drained soil in Tropical region.

Taxonomic status : Frequent.

IUCN Category : The taxon has not been assessed against the criteria as described in IUCN, 2014.

Associates : It grows near the streams on a moist soil alongwith pteridophytes and moisture loving plants.

Species examined : Mizoram, Lengteng W.S. Champhai Dist. *L. Vanchhawng & H. Lalramnghinglova* 42889(MZU).

Distribution : The plant is indigenous to southern Asia but now cultivated in many other tropical regions, such as Malaysia, Indonesia, Thailand, Vietnam, Myanmar and Cambodia (Burkill, 1966). In india, *Curcuma aeruginosa* is endemic to North East India and South India.

Uses : 1) Rhizome of this plant is used medicinally to treat asthma and cough, scurvy and mental derangements. It is considered to be depurative and used both internally and externally for treating exanthema and also as a poultice for itching (Perry, 1980).

2) Crushed rhizome is added in a beverage given to women in confinement to accelerate the lochia and decrease pain and inflammation of uterus (Perry, 1980; Pongbunrod, 1979).

Remarks : **First reported from Mizoram.**

5.6.2. ***Curcuma amada*** Roxb. in Asiat. Res. 11: 341. 1810 & Fl. Ind. 1: 33. 1820; Baker in Hook. f., Fl. Brit. India. 6: 213. 1890; Fischer in Gamble, F. Pres. Madras 3: 1036. 1957; Haines, Bot. Bih. Or. 1135. 1924; H. Lalram. Ethn. Med. Pl. Mizoram.

Photoplate-V (D-F)

Scientific name *: Curcuma amada Roxb.*

Local Name : Thei-hai-nam (L.Vanchhawng, 2014).

Common Name : Mango Ginger (English), Amba Haldi (Hindi).

Locality : Murlen N.P., Champhai Distrct.

Habit : Perennial rhizomatous aromatic herb

Habitat : Sub tropical semi-evergreen forest.

Botanical Description : *Rhizome* large, 4-5 x 3-4 cm, light yellow inside, white towards the periphery, mango-like odour and taste pungent. *Roots* fleshy, root tuber absent. *Pseudostem* 30-35 cm tall. *Leaves* long, petiolate, oblong-lanceolate, tapering at both ends, lower surface pu berlous, upper glabrous, tip hairy. *Flowers* large *ca.* 5 cm long, longer than the bract, white or pale yellow, arranged in spikes in the centre of tuft of the leaves; *calyx* transparent white, glabrous, 0.8-1.0 cm, minutely toothed; *corolla tube* whitish; upper lobe beaked, 1.7 x 1.6 cm; side lobes oblong, 2.3 x 0.9 cm; *lip* semi elliptic, pale yellow, 3-lobbed with the mid lobe emarginated. *Ovary* trigonous, 3 mm long, tri-carpellary, syncarpous with many ovules, densely hairy. *Style* long, filiform. *Stigma* closely appressed within the anther lobes. *Fruit* setting not seen.

Phenology : Flowering : June -August.
Fruiting : Not seen.

Ecological status : Grows luxuriantly in tropical soils with good drainage.

Ecological status : Rare.

IUCN Category : The IUCN does not hold any information.

Associates : Domesticated in home garden with *Curcuma sp.* in an open space.

Species examined : Mizoram, Murlen N.P., Champhai Dist. *L. Vanchhawng & H. Lalramnghinglova* 42881(MZU).

Distribution : *Curcuma amada* is widely cultivated in India apart from Malaysia, China, Bangladesh, Myanmar, Thailand, Japan and Australia. It is wild in parts of W. Bengal, Uttar Pradesh, Karnataka, Tamil Nadu and cultivated in Gujarat. In Mizoram, the plant is domesticated in Southern region and found in Murlen Village.

Uses : The ancient testimony for the use of this plant as medicine was well documented in the treatise of Ayurveda and dates back to the pre-historic Vedic era.

1) The rhizomes of this plant are useful in vitiated conditions of *pitta*, anorexia, dyspepsia, flatulence, colic, bruises, wounds, chronic ulcers, skin diseases, pruritus, fever, constipations, strangury, hiccough, cough, bronchitis, sprains, gout, halitosis, otalgia and inflammations (Warrier *et al*, 1994).

2) The tubers are regarded as cooling and as useful in prurigo. Tubers, made into a paste with spirit and egg-white is applied for chronic rheumatism and bruises. Rhizome is also used in applications over contusions and sprains (Chopra *et al*, 1980)

3) Roots are expectorant and astringent, useful in diarrhea and gleet. (Sabu, 2006).

4) Tubers are also used as condiments and vegetable (Watt, 1972)

5) Tubers rubbed with the leaf-juice of *Caesalpinia bonduc* is given for worms (Nadkarni, 1982).

6) Mango ginger has a typical exotic flavour of raw unripe mango. Therefore, it is used as a basic ingredient in pickles, preserves, candies, sauces, curries, salads and so on (Verghese 1990; Shankaracharya 1982).

5.6.3. ***Curcuma aromatica*** Salisb. Parad. Lond. 20: t. 96. 1807; Baker in Hook. f. Fl. Brit. India 6: 210. 1890; Fischer in Gamble, Fl. Pres. Madras 3: 1036. 1957; A.S. Rao & D.M. Verma in Bull. Bot. Surv. India 14(1-4): 122.1972. Dassanayake in Fl. Ceylon 4: 503. 1983; S. Kumar, Zingib. Sikkim 31. 2001; H. Lalram. Ethn. Med. Pl. Mizoram 121. 2003; M. Sabu, Zingib. Cost. South Ind. 131-142. 2006.

Photoplate-V (I-J)

Scientific name : *Curcuma aromatica* Salisb.

Local Name : Ai-hainam (Lalramnghinglova, 2003).

Common Name : Wild Turmeric (English)**,** Jangli Haldi (Hindi).

Locality : Sialsuk, Aizawl District; Samtlang, Champhai District in private farms.

Altitude : 500 - 1500 m.

Habit : Perennial tuberous herbs.

Habitat : Sub tropical semi evergreen forest.

Botanical Description : *Rhizome* aromatic, yellow which is internally orange-red in colour. *Leaves* elliptic or lanceolate-oblong, caudate-acuminate, 30-60 x 10-14 cm, pubescent below. *Inflorescence* 15-30 x 9 cm, generally appearing before the leaves, produced laterally to the leaf turf on

acout 5-8 cm sheath-covered peduncle; *bracts* ovate, recurved, more or less tinged with red or pink. *Flowers* arise from rhizome; *calyx* 2 cm long, dorsally split, tip 3-lobed, sparsely pubescent; *corolla tube* just exceeding the calyx, pinkish white, dorsal lobe broadly ovate, mucronate; *lip* yellow; *labellum o*rbicular 3-lobed, deep yellow; *lateral staminodes* as long as the corolla lobes. *Fruits* dehiscent, globose, 3-valved capsules.

The plant grows rapidly during the summer months of monsoon season. Its foliage will begin to die down in winter and rhizomes remained dormant.

Phenology : Flowering : June - August.
Fruiting : Not seen.

Ecological status : The species inhabits warm forest area having a good drainage. Generally, it is grown on different types of soils with high rainfall.

Taxonomical status : Rare.

IUCN Category : The taxon has not been assessed against the criteria as described in IUCN, 2014.

Associates : There is no associates as such; the plant is cultivated in pure form, monoculture on sandy-loam and loamy soils in an open area or *jhums.*

Species examined : Mizoram, Sialsuk, Aizawl Dist. *L. Vanchhawng & H. Lalramnghinglova* 42835(MZU).

Distribution : Wild turmeric is found wild throughout India and cultivated in Bengal and Kerala. It is distributed in Burma, Bhutan, Nepal and Sri Lanka (Christophe, 2012).

It is cultivated in Mizoram for the aromatic rhizome in *Jhum* lands or gardens.

Uses : 1) Rhizomes are used in combination with astringents and romatics for bruises, sprains, hiccough, bronchitis, cough, leucoderma and skin eruptions (Warrier *et al*, 1994).

2) The dried rhizome is used as a carminative and aromatic adjunctant to other medicines (Nadkarni, 1998).

3) Oil is used for treatment of early stage of cervix cancer (Asolkar *et al*, 1992).

4) In China, rhizome is used to cure flatulence, fatigue, epilepsy, delirium, rheumatism and to induce menses (Christophe, 2012).

5.6.4. ***Curcuma caesia*** Roxb. In Asiat. Res. 11. 334. 1810; Baker in Hook. f. Fl. Brit. India 6: 1890; Kumar in J. Econ. Tax. Bot. 15: 722. 1991; S. Kumar, Zingib. Sikkim 31-33. 2001; H. Lalram. Ethn. Med. Pl. Mizoram 122. 2003. **Photoplate-VI (A-C)**

Scientific name : *Curcuma caesia* Roxb.

Local Name : Ailaidum (Mizo).

Common Name : Black zedoary (English), Kala Haldi (Hindi).

Locality : Found cultivated in Perhsang, Zawlnuam, Mamit District; Vapar, Champhai District.

Altitude : 200 - 900 m.

Habit : Perennial, erect rhizomatous herb with large leaves.

Habitat : Tropical evergreen and semi-evergreen forests.

Botanical Description : An erect rhizomatous herb up to 0.5 - 1.2 m high. *Root stock* large, bluish black inside. *Rhizome* tuberous with camphoraceous sweet odour, sessile. *Leaves* large, broadly lanceolate or oblong, with a broad purple-brown cloud down the middle; 12-15 x 30-45 cm; tapering to the base. *Inflorescences* 15-20 cm long dense spike, which arises much before the opening of leaf; *bracts* green, bracts of coma tinged with pink or bright red, tending to crimson. *Flowers* pale yellow, reddish at outer border, shorter than the bracts; *calyx* 10-15 mm, obtuse and 3 toothed; *collora* long tubular, pale yellow lip-3 lobed, semi- elliptic. *Staminode* filiform. *Fruit* not seen.

Phenology : Flowering : June - July.
. Fruiting : Not seen.

Ecological status : *Curcuma caesia* is a tropical plant and grows in a humid warm weather with a lot of rainfall. Open or partially shaded areas with a tilted sandy loamy soil are the best for this plant.

Taxonomical status : Frequent.

IUCN Category : The taxon has not been assessed against the criteria as described in IUCN, 2014.

Associates : The plant is cultivates in association with other *Curcuma* spp. Or in pure form in tilted sandy-loam soil in open or partial shaded areas.

Species examined : Mizoram, Vapar, Champhai Dist. *L. Vanchhawng & H. Lalramnghinglova* 42864(MZU).

Distribution : *Curcuma caesia* is widely distributed in India, and in tropical and subtropical regions of Asia, especially Thailand, Indonesia and Malaysia. In India, the plant is mostly found in Bengal and north-eastern part of the country including Assam, Arunachal Pradesh, Meghalaya, Mizoram and some parts of central India.

Uses : 1) The rhizome is bitter and the paste is applied on bruises, sprains and rheumatic anthritis. (Lalramnghinglova, 2003; Sarangthem & Haokip, 2010; Trivedi, 2003).

2) Dried rhizomes, root paste and leaves of *Curcuma caesia* are used for leprosy asthma, cancer, wounds, impotency,fertility, tooth ache pile problem and leucodermia (Israr *et al.,* 2012; Syamkumar & Sasikumar 2007; Ravindran *et al.*, 2007).

3) The rhizomes are used in the treatment of smooth muscle relaxant activity (Arulmozhi *et al.,* 2003). It is also used for the treatment of haemorrhoids, leprosy, asthma, cancer, epilepsy, fever, wound, vomiting, menstrual disorder, anthelmentic, aphrodisiac, inflammation, gonorrhoeal discharges (Sasikumar, 2005).

4) Decoction of fresh rhizome as anti-diarrhoetic and applied the paste of fresh rhizome in case of snake and scorpion bite (Kagyung *et al,* 2010; Tag *et al,* 2007).

5) Crushed rhizome paste is applied against cur or injury to control bleeding and quick healing (Trivedi, 2003).

5.6.5. ***Curcuma longa*** Linn. Sp. Pl. 2. 1753: Baker in Hook. f. Fl. Brit. India. 6: 214. 1890; Burtt in Notes Roy. Bot. Gard. Edin. 35(2): 212. 1977. *C. domestica* Valet. In Bull. Jard. Bot. Buitenz. 27(3): 31. 1918; S. Kumar, Zingib. Sikkim 33-34. 2001; N.P. Singh *et. al*. in Fl. Mizoram 1:34-85. 2002; H. Lalram. Ethn. Med. Pl. Mizoram 123. 2003; M. Sabu, Zingib. Cost. South Ind. 160-163. 2006. **Photoplate-VI (D-F)**

Scientific name : *Curcuma longa* Linn.

Local Name : Ai-eng (Mizo).

Common Name : Turmeric (English), Haldi (Hindi).

Locality : Cultivated throughout Mizoram.

Altitude : 400 - 1800 m.

Habit : Rhizomatous herbaceous perennial plant.

Habitat : Tropical and subtropical region.

Botanical Description : A perennial herb to 90 cm high. *Rhizome* cylindric, ovoid, branched, yellow to deep orange-yellow inside, strongly aromatic. *Leaves* large, 10-25 x 30-70 cm, oblong-lanceolate, caudate-acuminate, base tapering; *petiole* 20-45 cm; *leaf blade* green, oblong or elliptic. *Inflorescence* terminal on pseudostem. *Flowers* pale yellow in bracteates in an erect spike, bracts pouched, pale green; *calyx* white, short; *corolla* bright yellow. *Lateral staminodes* shorter than labellum. *Labellum* yellow, obovate. *Ovary* inferior, 3-celled; *stigma* 2-lipped.

Phenology : Flowering : August & September.

. Fruiting : September & October.

Ecological status : *Curcuma longa* is found in tropical and subtropical regions. It is grown in various soil types, but prefers well-drained, loose and friable, fertile loam or clay loam, with good organic matter and prefers humid conditions. It is cultivated extensively throughout the warmer parts of the world.

Taxonomic status : Very common, Cultivated.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : Monocultured in paddy fields and in *jhum* lands or intercropped with *Cassia laevigata, Manihot esculentus* and *Oryza sativa* in an open spaces.

Species examined : Mizoram, Vapar, Champhai Dist. *L. Vanchhawng & H. Lalramnghinglova* 42865(MZU).

Distribution : The origin of *Curcuma longa* is not certain but it is believed to originate from southern Asia, most probably from India. The plant is cultivated in China, S.E. Asian countries and throughout India; very common in southern part of India, so also in Mizoram.

Uses : 1) Turmeric is used extensively in the Indian systems of medicine. In Ayurvedic medicine turmeric has a long history of use as an anti-inflammatory drug for arthritis. In both the Ayurvedha and Siddha systems of medicine, a turmeric paste is used topically to treat ulcers and scabies.

2) It is proved that the antioxidants present in turmeric neutralize carcinogenic free radicals. It is evaluated and proved the anticancer activity of turmeric. (Kuttan *et al.,* 1985).

3) A coating of turmeric powder or a thin paste is applied on small pox and chicken pox patients (Nadkarni, 1976).

4) Experimental study on the efficacy of turmeric on blood sugar found that both turmeric and curcumin decreased blood sugar level. Curcumin was found to be capable of decreasing the complications in diabetes mellitus (Sajithlal *et al.,* 1998).

5) The juice of turmeric has anti-helminthic property on internal use. Turmeric powder or paste boiled in water with a little common salt is taken as an anti-helminthic (Nadkarni, 1976).

6) Turmeric is anti-inflammatory and anti-purulent in nature. It is reported that volatile oil of turmeric as oral drug in a clinical trial was found very effective in the treatment of bronchial asthma (Jain *et al.,* 1990). Fresh rhizome proved effective against whooping cough and other coughs and in dyspnea (Khare, 2000).

7) Fresh rhizome is crushed and applied externally on sprains, wounds and swelling and then bandaged (Lalramnghinglova, 2003).

8) *Food:* Turmeric powder is an indispensable ingredient in curry and used for coloring.

5.6.6. ***Curcuma rubrobracteata*** Škorničk., M. Sabu & M. Prananthkumar, Gard. Bull. Singapore. 55(1): (2003) 89. **Photoplate-VI (G-H)**

Scientific name : *Curcuma rubrobracteata* Škorničk., M.Sabu & Prasanthk.

Local Name : Not available.

Common Name : Not available.

Locality : Ngengpui W.S., Lawngtlai Dist.

Altitude : 400 - 1200 m.

Habit : Rhizomatous herb.

Habitat : Sub tropical semi evergreen and deciduous forests.

Botanical Description : Rhizomatous herb, up to 1.6 m high. *Rhizome* creeping, slender, 10-30 cm, light brown, whitish yellowish inside, aromatic, taste very bitter; *tuber* sessile. *Leafy shoot* up to 1.5 m; *pseudostem* green. *Leaves* 4-6, petiolate, elliptic lanceolate 35-60 x 10-16 cm, adaxially green, abaxially pale green, glabrous, base attenuate, tip a cuminate; *ligule* 1 mm long, light green, translucent; *petiole* glabrous, green, 10-45 cm long. *Inflorescence* terminal, *ca.* 3-10 cm above ground; *bract* bright red, yellowish green towards the base, glabrous, hairy; *bracteoles* one per flower, glabrous, white, translucent with reddish dots. *Flowers* 6 cm long, yellow orange; *calyx* 1.2 cm, white, translucent, 3-toothed; *corolla tube* 3.5-4.0 cm. light orange; *corolla lobes* light yellow orange. *Labellum* 15 x 17 mm, periphery yellow orange, centre deep yellow orange, obscurely 3-lobed. *Lateral staminodes* yellow orange, hooded over the anther. *Stamen ca.*9 mm long; *anther* orange; *filament* yellow orange, 5 mm long. *Ovary*

trilocular, pubescent with 0.6 mm long hairs; *ovules* many. *Fruit* not seen.

Phenology : Flowering : August & September.
. Fruiting : Not seen.

Ecological status : Growing in deciduous and evergreen forests and plantation areas. It is also found along roadsides and plantation area as undergrowth.

Taxonomical status : Rare.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : It grows under plantation of *Tectonia grandis* alongwith *Imperica cylindrical, Hedyotes scandens, Mikania micrantha* etc.

Species examined : Mizoram, Ngengpui W.S., Lawngtlai Dist. *L. Vanchhawng & H. Lalramnghinglova* 42854(MZU).

Distribution : North East India, Myanmar and Thailand.

Uses : Not known.

5.6.7. ***Curcuma zedoaria*** (Christm.) Rosc., Trans. Linn. Soc. London 8: 354. 1862; Baker in Hook. f. Fl. Brit. India 6: 210. 1890; Burtt, Gard. Bull. Singapore 30: 59. 1977; Kumar in J. Econ. Tax. Bot. 15: 723. 1991; S. Kumar, Zingib. Sikkim 34-36. 2001; H. Lalram. Ethn. Med. Pl. Mizoram 124. 2003.

Scientific name : *Curcuma zedoaria* (Christm.) Rosc.

Local Name : Ai-dizung (Lalramnghinglova, 2003).

Common Name : Round zedoary, White zedoary (English); Kachur (Hindi).

Locality : Cultivated in south-western part of Mizoram.

Altitude : 200 - 500 m.

Habit : Perennial rhizomatous herb.

Habitat : Tropical and sub-tropical wet forests.

Botanical Description : Large perennial herb with underground tuberous rootstock. *Rhizomes* with cylindric annulate tubers, brownish outside, pale yellow and faintly aromatic inside. *Pseudostem* 50-100 cm high. *Leaves* 4-6 with long petioles, 10-15 x 20-45 cm, elliptic-oblong to oblong-lanceolate, finely acuminate and curled, upper side purple blotched on either side of the midrib. *Flowers* pale yellow in spikes; *bract* bright red, the lower ones ovate, green; *calyx* pinkish; *corolla lobes* yellowish white with pinks; *lip* pale yellow, emerginate, 3-lobbed. *Ovary* villous. *Fruits* capsules, membranaceous, globose, 3-valved.

Phenology : Flowering : May - June.
. Fruiting : July - August.

Ecological status : White Zedoary grows in tropical and subtropical wet forest regions. The plant prefers rich loamy soil with humus content. Partially shaded area favors better growth to the species.

Taxonomic status : Infrequent, Rare.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Eurya acuminate*, *Curculigo* spp.; in moist shady places in mixed secondary forests; occasionally found in new *jhum* lands.

Species examined : Mizoram, Hauruang, Lunglei Dist. *L. Vanchhawng & H. Lalramnghinglova* 42806 (MZU).

Distribution : It is believed that the plant is originated from North East India. *Curcuma zedoaria* is native of Bangladesh and mainly distributed in South East Asia, China, Vietnam, India, Bangladesh, Indonesia, Malaysia and Japan; wild in eastern Himalayas and in moist deciduous forests coastal tract of Kerela. It is cultivated throughout India; very rare in Mizoram, found in tropical secondary forests.

Uses : 1) The rhizome is used as appetizer and tonic; particularly prescribed to ladies after childbirth. Root powder is a good substitute for many foreign foods for infants. Decoction of fresh rhizomes is also used for blood purification.

2) The rhizome is crushed and mixed with water and taken orally for piles and epileptic seizure. For worms, the juice from the tubers is given to children (Lalramnghinglova, 2003).

3) The rhizome is used for curing stomach diseases, toothache, blood stagnation, leucoderma, tuberculosis, enlargement of spleen, and for promoting menstruation in traditional medicine in Asia (Saikia & Nath, 2003).

4) It is used traditionally for the treatment of menstrual disorder, dyspepsia, vomiting (Prajapati *et al.,* 2003), and for cancer related disease (Rahman *et al.,* 2013).

5) The rhizome of *C. zedoaria* is also reported to possess rubifacient, carminative, expectorant, demulcent, diuretic and stimulant properties while the root is used for the treatment of flatulence, dyspepsia, cold, cough, and fever (Wilson *et al.,* 2005).

6) In the folk medicinal system of Bangladesh, the rhizomes of the plant are used for treatment of leprosy, mental disorders, leucorrhea, diabetes, hepatitis, diarrhea and hemorrhoids (Rahmatullah *et al.,* 2012).

7) In traditional Eastern medicine, rhizomes of the plant are used to aid digestion, as relief for colic and as a blood purifier. It is also used to neutralize the venom of the Indian cobra (Daduang *et al.,* 2005).

5.7. ELETTARIA Maton, Trans. Linn. Soc. London 10: 250. 1811; Benth. & Hook. f. Gen. Pl. 3: 646. 1883; Baker in Hook. f. Fl. Brit. Ind. 6: 251. 1892; Schum. in Pflanzenr. Zingib. 267. 1904; Dassanayake, Fl. Ceylon 4: 528-529. 1983.

Rhizome perennial, thick, hard and woody, branched, horizontal. *Leafy stems* up to 3-4 m. *Leaves* distichous, subsessile; *ligule* small; *lamina* 50-100 x 6-8 cm, lanceolate, tip a cuminate. *Inflorescence* panicle, often subterranean, only the tips of the flowers borne above ground level; usually on a long prostrate or occationally erect peduncle borne separately from the leaves; *bracts* remote, each subtending a several flowered cincinnus; *bracteoles* tubular; *calyx* unilaterally split, 3-lobed; *corolla tube* equaling the calyx. *Labellum* obovate, narrowed

at the base. *Lateral staminodes* small, subulate. *Anther* subsessile, connective sometimes prolonged into a short erect crest. *Capsule* globose or oblong. *Seeds* aromatic, aril absent.

5.7.1. *Elettaria cardamomum* (Linn.) Maton, Trans. Linn. Soc. London 10: 254, t. 5. 1811; Baker in Hook. f. Fl. Brit. Ind 6: 251. 1892; Fischer in Gamble, Fl. Pres. Madras 3: 1041. 1957 (repr. Ed); Burtt in Botany & History of Hortus Malabricus ed. K.S. Manilal, 1980. **Photoplate-VI (I-M)**

Scientific name : *Elettaria cardamomum* (Linn.) Maton.

Local Name : Elaichi (Mizo).

Common Name : Lesser cardamom, Malabar cardamom (English); Elaichi (Hindi)

Locality : Cultivated in homestead gardens in Khanpui, Lunglei, Champhai, Serchhip etc.

Altitude : 600 - 1000 m.

Habit : A tall herbaceous perennial with a thick fleshy or woody rhizome.

Habitat : Sub-tropical semi evergreen forests.

Botanical Description : A mature cardamom plant may measure 2 - 4 m in height. *Rhizome* perennial, thick, hard, woody. *Leafy shoot* 3-4 m tall. *Leaves* distichous, shortly petiolate; *petiole* 1-2 cm, glabrous above, slightly pubescent or glabrous below; *ligule* 3 mm. *Inflorescence* directly produced from the rhizome, peduncle 30-40 cm, prostrate; *bracts* lanceolate, acute, glabrous; *bracteolates* 2.5-3 cm, tubular, membranous, glabrous*; calyx* 1-1.5 cm, shortly lobed, lobes mucronate, glabrous or minutely pubescent; *corolla tube* almost

equal to the calyx. *Labellum* obovate, apex slightly 3-lobed, white with violet stripes in the centre, glabrous. *Anther* sessile. *Style* long, filiform, stigma bilipped, fringed with hairs. *Ovary* 2-3 mm long, tricarpellary; *ovules* many on axile placenta, glabrous. *Fruits* trilocular capsules, fusiform, pale yellow to green, 15-20 brownish black seeds.

Phenology : Flowering : May - August.
Fruiting : September – November

Ecological status : Grown in evergreen rain forests usually occur in occur in the pre-climax stage of the forest. Cardamom is generally grown in forest loamy soils rich in available phosphorus and potassium, but well drained deep loamy soils abundant in humus is ideal.

Taxonomical status : Frequent.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : Cardamom is grown in plantations under the shade of tall forest trees.

Species examined : Mizoram, Khanpui, Aizawl Dist. *L. Vanchhawng & H. Lalramnghinglova* 42805 (MZU).

Distribution : The plant has originated in India, wild in South India, Thailand and Sri Lanka. The western ghat forests of Malabar Coast are the centre of origin and diversity of Cardamom. India is the largest producer of cardamom with cultivation mainly confined to the southern states of

Kerela, Karnataka and Tamil Nadu. The occurrence of this species in Burma, Indo-china and malaesia in wild condition is doubtful.

Uses : 1) The dried capsules, the essential oil, oleoresin and tinctures are extensively used in the formulation of compounded mixtures for liquors beverages baked goods, canned foods, meats, sauces and condiments (Skaria *et al.,* 2005).

2) Cardamoms are stimulant, carminative and flavouring agent. They are used for flavouring curries, cakes, bread and other culinary purposes. It is a common practice to offer cardamoms at the end of a meal as a digestive and breathe sweetener.

3) Cardamom has been used in traditional medicine for asthma, constipation, colic, diarrhoea, dyspepsia, hypertension, epilepsy and is considered useful as antibacterial, antifungal, antiviral, carminative, diuretic and stomachic (Kapoor, 1990; Duke *et al.,* 2002).

3) The oil and oleoresins are also use in the preparation of aromatic, stimulant, stomachic and diuretic tinctures (Skaria *et al.,* 2005).

5.8. ETLINGERA (Roxb.) R.M. Sm. In Notes Roy. Bot. Gard. Edin. 43: 246. 1986; Giseke, Prael. Ord. Nat. Pl. 209. 1792; T.L. Wu & Larsen in Z.L. Wu & P.H. Raven, eds. Fl. China 24: 370–377. 2000.

Rhizomes creeping. *Pseudostems* robust, 3-5 m high. *Leaves* petiolate, lanceolate, large. *Inflorescence* arising from rhizomes, a spike or head with flowers arranged in 3 or 4 concentric circles on a flat receptacle, base surrounded by numerous sterile, involucral bracts; *peduncle* raised well above ground and long, or embedded in ground and short; *bracts* 1-

flowered; *bracteoles* long tubular; *calyx* tubular, membranous, split on 1 side, apex 3-toothed; *corolla tube* equaling or longer than calyx; *lobes* 3, much shorter than tube. *Lateral staminodes* absent; *labellum* tongue-shaped, *ca.* 3-lobed, much longer than corolla lobes. *Stamen* shorter than labellum; free part of filament very short and rather broad; *anther* bent forward, connective appendage absent. *Ovary* 3-loculed; ovules numerous per locule. *Capsule* fleshy, indehiscent, smooth, longitudinally ridged, or with obtuse warts in rows.

5.8.1. ***Etlingera linguiformis*** R.M. Sm. In Notes Roy. Bot. Gard. Edin. 43: 246. 1986; T.L. Wu & K. Larsen in Z.L. Wu & P.H. Raven, eds. Fl. China 24: 322–377. 2000.

Photoplate-VII (A-C)

Scientific name : *Etlingera linguiformis* (Roxb.) R.M. Smith

Local Name : Lei-Aidu-chhia (L. Vanchhawng, 2014).

Common Name : Tera (Bengali), Sayang (Malaysian).

Locality : Thenzawl, Serchhip District; Reiek forest, Dampui forests, Mamit District; Lengteng W.S., Champphai District; Saireptlang forests, Lunglei District. The plant is very common in Mizoram.

Altitude : 400 - 1300 m.

Habit : A tall, leafy, rhizomatous perennial herb.

Habitat : Sub-tropical evergreen and semi-evergreen forests.

Botanical Description : Rhizomatous perennial herbs, up to 2m tall. *Rhizomes* long, creeping, strongly aromatic. *Leaves* simple, distichous, lamina oblong to lanceolate, 20-35 x 4-6 cm, glabrous, shining above; *ligules* entire, *ca*. 5mm long, glabrous; *petioles ca*. 2cm long. *Spikes* few-flowered,

arising from rhizomes, oblong, narrowed at both ends, 6-8 cm long, red, flowers arranged in 3-4 concentric circles; *bracts* closely imbricate, oblong, acute, white below. *Flowers* red except the lip; *calyx* split on one side, 2-toothed at apex; *corolla tube* as long as calyx, 3-lobed; *lip* oblong, tongue-shaped, *ca*. 5cm long, bright yellow with reddish tinge, apex bifid. *Filament ca* 1 cm long, fused with the lip upto *ca* 8 mm, *anther ca* 8 mm long, white. *Ovary* hairy, stigma red. *Fruits* densely covered with subulate flexible spines.

Phenology . : Flowering : March - May.
Fruiting : June - August.

Ecological status : The species was found growing on moist loamy soil in damp places of forest edges and along water canals.

Taxonomic status : Common.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Clerodendrum bracteata*, *Erianthus longiseosus*, *Mussaendra roxburgii*, *Albizia procera*, *Costus speciosus* etc.

Species examined : Mizoram, Thenzawl, Serchhip Dist. *L. Vanchhawng & H. Lalramnghinglova* 42807 (MZU).

Distribution : India (North East India and Andaman & Nicobar Islands), Myanmar. The plant is common in throughout in Mizoram, usually in clearings and damp places or river banks, in both tropical evergreen and semi-evergreen forests.

Uses : Pieces of rhizomes are chewed with betel leaf to cure sore throat (Yusuf *et al.* 2009). The rhizomes are crushed and the extract, mixed with water, is consumed to treat fever (Ramana *et al.*, 2012).

5.9. GLOBBA (Linn.) Mant. 2 : 143. 1771; Benth. in Benth. & Hook. f. Gen. Pl. 3 : 640. 1883; Baker in Hook. f. Fl. Brit. Ind. 6 : 201. 1890.

Herbs with creeping rhizome and erect stem. *Leaves* distichous, mostly narrow, oblong-lanceolate. *Flowers* yellow, in terminal spikes or panicles, buds often replaced by bulbils; *calyx* funnel-shaped, 3-lobed; *corolla* tube slender, exceeding the calyx, with ovate subequal lobes usually finally reflexed. *Lateral staminodes* short, elliptic, attached to corolla tube at the same level as the corolla lobes and equaling or exceeding them in length. *Filament* long, incurved, with 2 dorsal appendages; *anther* oblong, small, often bear 2 or 4 lateral appendages; *lip* deflexed. *Ovary* one celled with many ovules on 3 parietal placentae; *style* filiform lying in a groove of the filament; *stigma* turbinate. *Fruit* small dehiscent capsule. *Seeds* small, often pubescent, ovoid, with a small white lacerate aril.

Key to the species of Mizoram *Globba*

1a. Anther without appendages, Bracts or bracteolaes caducous……. 2

1b. Anther with appendages on each side, Bracts or bracteolaes persistent……....5

2a. Bulbils present.……...……..3

2b. Bulbils absent ……...…….…..4

3a. Bulbils present at the base of inflorescence, bract with subtending cincinni of 4-6 yellow flowers …….……..5.9.2. *G. multiflora*

3b. Bulbils produced in upper part of inflorescence, bracts with 2-3 tightly clustered, bright yellow flower..…….…....5.9.1. *G. clarkei*

4a. Corolla tube thrice the length of calyx. ……..….5.9.4. *G. racemosa*

4b. Corolla tube twice the length of calyx……...…..5.9.3. *G. orixensis*

5a. Leafy shoot 30-60 cm tall, bracts light orange to light green, corolla tube orange……5.9.5. *G. Schomburgkii*

5b. Leafy shoots ca. 30-40 cm high, bracts violet coloured, corolla tube reddish-purple……...……..5.9.6. *G. wardii*

5.9.1. ***Globba clarkei*** Baker in Hook. f. Fl. Brit. India 6:201. 1890; A.S. Rao & D.M. Verma in Bull. Bot. Surv. India 11(3-4); 246. 1969; Noltie, Fl. Bhutan 3(1): 224. 1994. **Photoplate-VII (D-F)**

Scientific name : *Globba clarkei* Baker.

Local Name : Not available.

Common Name : Not available.

Locality : Murlen N.P., Champhai District; Dampui Reserve Forest, Mamit Distrcit; Hmar Chaltlang, Kolasib Distrcit; Sairep Natural Forest, Lunglei District.

Altitude : 500 - 1500 m.

Habit : Aromatic rhizomatous perennial herb.

Habitat : Tropical and sub-tropical evergreen forests.

Botanical Description : Plants, stout, erect, 0.5-1.5 m. *Leaves* oblong-lanceolate, long caudate, 20-30 x 3-6 cm, glabrous or pubescent beneath, upper surface usually sparsely hairy; *sheaths* often purplish; *ligules* bilobed, 1-2 mm, pubescent. *Inflorescence* terminal, 20-30 cm, bulbils produced in upper part; *bracts ca.* 2 cm, soon deciduous, each

subtending a cincinnus of 2-3 tightly clustered, bright yellow flower; *bracteoles* minute, soon deciduous. *Flowers* elongate panicle associated with many tiny white or brownish green bulbils; *calyx* 3-lobed, 5-7 mm, purplish brown; *petals* ovate, 5-6 mm; *corolla tube* rather more than twice length of calyx, yellow, 15-20 mm. *Lateral staminodes* longer than and narrower than petals; *lip* 1-1.5 cm, bilobed. *Anther* lanceolate, crested, no appendage. *Capsules* smooth, trilobed.

Phenology : Flowering & Fruiting : June - August.

Ecological status : The plants grow as undergrowth in shaded moist places of primary forest or along forest margins.

Taxonomical status : Rare.

IUCN Category : This taxon has not yet been assessed for the IUCN Red List.

Associates : *Jasminum nervosum, Embelia nutans, Lagerstoemia speciosa, Garcinia sopsopia* etc.

Species examined : Mizoram, Murlen N.P., Champhai Dist. *L. Vanchhawng & H. Lalramnghinglova* 42870 (MZU).

Distribution : *Globba clarkei* is native to Nepal, Bhutan, Bangladesh and Thailand. In India, the species is found in Sikkim, Assam, Arunachal Pradesh, Tripura and Mizoram.

Uses : Juice of rhizome and the decoction of seed are taken orally for food poisoning.

Remarks : **First reported from Mizoram.**

5.9.2. ***Globba multiflora*** Wall. ex Baker in Hook. f. Fl. Brit. India 6: 202. 1890; Fischer in Rec. Bot. Surv. India 12(2): 144. 1938; Rao & Verma in Bull. Bot. Surv. India 14(1-4): 118. 1972; Deb, Fl. Tripura 2; 375. 1983; Noltie in Fl. Bhutan 3(1): 224. 1994.

Photoplate-VII (G-J)

Scientific name : *Globba multiflora* Wall. ex Baker.

Local Name : Not available.

Common Name : Not available.

Locality : Murlen N.P., Champhai Dist; Pualreng W.S., Kolasib Dist; Lungkawlh Reserve Forest, Serchhip Dist; Sairep Natural Forest, Lunglei District.

Altitude : 500 - 1500 m.

Habit : Rhizomatous perennial herb.

Habitat : Tropical and sub-tropical evergreen forest.

Botanical Description : Leafy stem, erect, upto 1m high. *Bulbils* present at lower nodes. *Leaves* oblong or elliptic oblong, 20-30 x 4-6 cm, pubescent beneath. *Inflorescence* long, half of the height of the plant; *bracts* small, soon deciduous, those at the base of inflorescence producing bulbils, those from upper part subtending cincinni of 4-6 yellow flowers; *bracteoles* minute, soon deciduous. *Flowers* in long narrow, villous panicle, not clustered; *calyx* 3-lobed, 3-4 mm; *corolla* 3 x length of calyx, orange

yellow, hairy without. *Lateral staminodes* 3-4 mm; *anther* not winged*; lip* shortly bilobed. *Capsule* smooth, sub-globose.

Phenology : Flowering & Fruiting: July - September.

Ecological status : It is found as undergrowth in tropical evergreen forest. The species is common along road side cutting and on shady and moist areas.

Taxonomical status : Rare.

IUCN Category : This taxon has not yet been assessed for the IUCN Red List (2014).

Associates : *Callicarpa arborea, Bombax ceiba, Blumea lanceolaria, Hedyotes scandens, Melocanna baccifera* etc.

Species examined : Mizoram, Vapar, Murlen N.P., Champhai Dist. *L. Vanchhawng & H. Lalramnghinglova* 42866 (MZU).

Distribution : Tropical region of *Indian Sub-continent*, Bangladesh, East Himalaya, Indo-China, Bhutan and Myanmar. In India, it is found in Tripura, Arunachal Pradesh, Assam and Mizoram.

Uses : 1) Hot decoction of rhizome is taken internally for the treatment of hoping cough.

2) Rhizomes are crushed and applied on injury or on body pain and swollen muscles.

Remarks : **First reported from Mizoram.**

5.9.3. ***Globba orixensis*** Roxb. in Asiat. Res. 11 : 358. 1810; Baker in Hook. f. Fl. Brit. India 6: 201. 1890; Haines, Bot. Bih. Or. 1129. 1924; Fischer in Rec. Bot. Surv. Ind. 12(2): 144. 1938; Deb, Fl. Tripura 2; 375. 1983. **Photoplate-VII (K-M)**

Scientific name : *Globba orixensis* Roxb.

Local Name : Not available.

Common Name : Waso-pan (Myanmar).

Locality : Lungkawlh Reserve Forest, Serchhip District; Murlen N.P., Champhai District; Phunchawng, Aizawl District.

Altitude : 400 - 1200 m.

Habit : An annual, small, rhizomatous herb.

Habitat : Tropical evergreen forest.

Botanical Description : *Rhizome* small. *Roots* many, fleshy. *Leafy shoot* 50-80 cm, erect. *Leaves* shortly petioled, lamina 15-25 x 5-8 cm, oblong to elliptic lanceolate, sub-caudate, glabrous on both the surface. *Inflorescence*s central, panicle nearly erect, branches; *bulbils* absent; *bracts* small, deciduous, 1-2.5 cm. *Flowers* small, sessile, deep orange-yellow; *calyx* 6-12 mm, greenish yellow, 3-toothed; *corolla tube* about twice the length of the calyx, slightly curved 3 lobed; *lip* ovate, as long as the reflexed petals, 2-lobed. *Filament* long, curved with central groove; *anther* ovate–oblong, without any appendage; *style* shorter than filament, stigma half immersed between the lobes of the anther.

Ovary unilocular with many ovules. *Capsule* warty. *Seeds* tomentose, reddish brown, ovoid, glabrous or hairy.

Phenology : Flowering : July - August.
. Fruiting : September - October.

Ecological status : Grown as undergrowth under tropical evergreen forest on a well drained loamy soil with rich humus.

Taxonomical status : Rare.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : It grows in forests as undergrowth at low and high altitudes.

Species examined : Mizoram, Lungkawlh, Serchhip Dist. *L. Vanchhawng & H. Lalramnghinglova* 42822 (MZU).

Distribution : Reported only from India. In India it occurs in Andra Pradesh, Bihar, Orissa, Tripura and throughout Eastern India.

Uses : The taxon has not been reported as having medicinal uses.

Remarks : **First reported from Mizoram.**

5.9.4. ***Globba racemosa*** Smith, Exot. Bot. 2: 115. T. 117. 1804; Baker in Hook. f. Fl. Brit. India. 6: 201. 1890; Haines, Bot. Bih. Or. 1129. 1924; Rao & Verma in Bull. Bot. Surv. Ind. 14: 118. 1972; Deb, Fl. Tripura 2:375-376. 1983.

Scientific name : *Globba racemosa* Smith.

Local Name : Kuaite-ai (Lalramnghinglova, 2014).

Common Name : Dancing girl ginger.

Locality : Murlen N.P., Champhai District; Lungkawlh Reserve Forest, Serchhip District; Thorang W.S., Lunglei District; Phawngpui N.P., Lawngtlai District; on roadsides near Chawnpui and Hmuifang, Aizawl District.

Altitude : 300 - 1100 m.

Habit : Terrestrial rhizomatous herb.

Habitat : Sub-tropical evergreen forest.

Botanical Description : Herbs about 1 m high, erect. *Rhizome* small, light yellowish. *Roots* thick, fleshy, pale brown. *Leaves* sub-sessile; *ligule* and mouth of leaf sheath ciliate; *leaf blade* oblong or ovate-lanceolate, 12-20 x 4-5 cm, glabrous or hairy along veins on both surfaces, base acute, apex caudate. *Inflorescence* a thyrse, 15-20 cm; *bract* caducous; bracteoles *ca*. 2 mm. *Flowers* yellow, with orange, glandular spots; *calyx* turbinate, 4-5 mm; *corolla tube* puberulous, about three times the length of the calyx, 1-1.5 cm; *lobes* reflexed, *ca.* 5 mm. *Labellum* reflexed, obcuneate, *ca.* 7 mm. *Filament* 1–1.2 cm; *anther ca.* 4 mm, without appendages. *Capsule* ellipsoid *ca.* 1 cm in diameter, smooth.

Phenology : Flowering : June & July.
Fruiting : August.

Ecological status : Grows in sandy loamy soil in lowland and Sub-tropical evergreen forest. It grows in shaded and moist places and makes an excellent potted indoor plant.

Taxonomical status : Very frequent.

IUCN Category : The species is listed as **'Least concern'** under version 3.1 of IUCN Red List category and Criteria.

Associates : *Centella asiatica, Oxalis corniculata, Hydrocotyle japonica, Achyranthes aspera, Cyathula prostrate, Bidens biternata* etc.

Species examined : Mizoram, Murlen N.P., Champhai Dist. *L. Vanchhawng & H. Lalramnghinglova* 42872 (MZU).

Distribution : Bangladesh, Bhutan, China, India, Myanmar, Nepal, Thailand, Vietnam.

Uses : Ornamental.

5.9.5. ***Globba schomburgkii*** J.D. Hook. f. in Bot. Mag. 103: t. 6298. 1876; K. Schum. in Engler's Bot. Jahrb. 27. 331; T.L. Wu & K. Larsen in Z.L. Wu & P.H. Raven, eds. Fl. China 24: 322–377. 2000. **Photoplate-VIII (A-B)**

Scientific name : *Globba schomburgkii* Hook. f.

Local Name : Ai-buk (Lalramnghinglova, 2014).

Common Name : Orange fairy ginger, Dancing lady ginger.

Locality : Cultivated in MZU Botanical Garden, Tanhril, Aizawl District.

Altitude : 600 - 1000 m.

Habit : A tender, small, perennial herb.

Habitat : Sub-tropical semi evergreen forests.

Botanical Description : *Rhizome* small, conical, light yellowish to grey inside. *Roots* many, thick, fleshy, white inside. *Leafy shoot* 30-60 cm tall, swollen near the rhizome. *Leaves* shortly petioled, ligule 2 mm long, oblong-lanceolate, tip acuminate. *Inflorescence* terminal, peduncle slender bearing many slender branches in the axils of primary bract towards the apex; branches bearing 4-5 flowers in a cincinnus; *bracts* many, lax, spreading, persistent, subtending one or more spherical bulbils, light orange to light green. *Flowers* 4-5 cm long, orange; *calyx* truncate, 4-5 mm long, shortly 3-lobed, glabrous, orange; *corolla tube* 1.5 cm long, recurved, throat hairy, orange. *Filament* 2.5 cm long, upcurved; *anther* small with two spreading; *style* long, filiform. *Ovary* 2 mm long, unilocular with many ovules on 3 parietal placentae. *Fruit* setting is very rare.

Phenology : Flowering : June - July.
Fruiting : August - September.

Ecological status : It occurs in both high and low altitude in a dense rain forest in a filtered shade. *Globba schromburgkii* prefers rich, well drained soil.

Taxonomical status : Rare.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Phyllanthus fraternus, Costus speciosus, Scleria sumatrensis, Mikania micrantha, Ageratum conyzoides, Osbeckia penducularis, Mussaendra glabra.*

Species examined : Mizoram, MZU Campus, Aizawl Dist. *L. Vanchhawng & H. Lalramnghinglova* 42801 (MZU).

Distribution : Throughout India, Southeast Asian countries like Bangladesh, Bhutan, China, Myanmar, Nepal, Thailand and Vietnam.

Uses : The plant is used break fever in Laos; it is also used to check bleeding and to heal wounds (Christophe, 2012). The rhizome produces Kaempferol that is anti-inflammatory and could be implicated in antipyretic and for wound healing.

Remarks : **First reported from Mizoram.**

5.9.6. ***Globba wardii*** (B.L. Burtt & R.M. Sm.) K.J. Williams, Amer. J. Bot. 91: 114. 2004. *Mantisia wardii* B.L. Burtt & R.M. Sm., Notes Roy. Bot. Gard. Edin. 28: 228. 1968; S.K. Singh & R. Kumar, Taiwania, 56(3): 261-264, 2011.

Photoplate-VIII (C-D)

Scientific name : *Globba wardii* (B.L. Burtt & R.M. Sm.) K.J. Williams.

Local Name : Phawngpui-ai (Lalramnghinglova & L. Vanchhawng, 2014)

Common Name : Not available.

Locality : Phawngpui N.P., Lawngtlai District.

Altitude : 1500 - 2000 m.

Habit : Rhizomatous perennial herb.

Habitat : Temperate and sub-tropical forests.

Botanical Description : *Rhizomes* small, creeping, yellow-grey inside; roots many, fleshy, tuberous, elongated. *Leafy shoots* slender, *ca.* 30-40 cm high bearing about 4-7 leaves. *Leaves* sessile, glabrous, 6-12 x 2-4 cm, apex apiculate, base auriculate, upper surface glabrous, lower surface minutely pubescent, ligulate; *ligule* semicircular, 0.5 mm, margins sparsely pubescent. *Inflorescence* terminal, a thyrse or lax raceme, 4.5-8 cm, straight, peduncle slender; *bracts* violet coloured, many, imbricate, persistent, 1.5 x 0.5 cm, elliptic-acuminate, elongate; *bracteoles* small, opposite to flowers, free at base; *calyx* campanulate, glabrous, 1cm long, apex sub-equally tri-lobed; *corolla tube* slender, much longer than the calyx, concave, 3-lobes three, ovate or oblong, unequal, reddish-purple. *Lateral staminodes* petaloid, 6-7 mm long, pale reddish-purple or golden yellow, apiculate. *Labellum* reflexed, adnate to filament to form a slender tube above lateral staminodes and corolla lobes, orange, basal auricles. *Filament* 1.5-2 cm long, curved, pale orange; *anther* purple, obtuse towards apex, appendiculate. *Ovary* unilocular; *ovules* many; *stigma* round, ciliate.

Phenology : Flowering & Fruiting: June - August.

Ecological status : The plant is growing terrestrially at Forest edges in meadows where the soil is red with adequate humus.

Taxonomical status : Rare.

IUCN Category : This taxon has not yet been assessed for the IUCN Red List (2014).

Associates : *Melocanna baccifera, Bergenia ciliate, Albizzia chinensis, Thunbergia grandiflora, Derris robusta* etc.

Species examined : Mizoram, Pawngpui N.P. *L. Vanchhawng & H. Lalramnghinglova* 42858 (MZU).

Distribution : It is only found in Myanmar and India (Mizoram).

Uses : Not known.

Remarks : This species is naturally occured (*in situ*) in National Parks in Mizoram and Myanmar. IUCN category Endangered (EN) is proposed as it has a very small population size and restricted distribution area.

5.10. HEDYCHIUM Koen. in Retz. Obs. Bot. 3:73. 1783; Benth. & Hooker. f. Gen. Pl. 3: 642. 1883: Baker in Hook. f. Fl. Brit. Ind. 6: 225. 1892; Schum. in Pflanz. Zingib. 40. 1904; T.L. Wu & K. Larsen in Z.L. Wu & P.H. Raven, eds. Fl. China 24: 322-377. 2000.

Herbs terrestrial or epiphytic, with tuberous rhizomes. *Pseudostems* erect, leafy. *Ligule* conspicuous; leaf blade usually oblong or lanceolate. *Inflorescence* a terminal spike, densely numerous flowered; bracts imbricate or lax, 1 or more flowered; *bracteoles* tubular; *calyx* tubular, usually split on 1 side, apex truncate or 3-toothed; *corolla tube* long, slender; lobes reflexed, linear. *Lateral staminodes* petaloid, larger than corolla lobes; *labellum* sub-orbicular, large, apex usually 2-cleft; claw long or short. *Filament* usually long, rarely absent; *anther* dorsifixed, base divaricate; *connective appendage* absent. *Ovary* 3-loculed, placentation axile. *Capsule* globose, 3-valved; *seeds* numerous; aril lacerate.

Key to the species of Mizoram *Hedychium*

1a. Filament absent or if present shorter than 1 cm long ……..…….5.10.11. *H. wardii.*

1b. Filament exceeding the length of 1 cm ……..…….2

2a. Filament with the length between 2-3 cm……...……...……..3

2b. Filament with the length of more than 3 cm……...……..4

3a. Flowers white tinged yellow or reddish at base, fragrant; bracts folded, greenish, lanceolate-oblong, glabrous or sparsely hairy……...……..5.10.7. *H. spicatum*

3b. Flower pale yellow, highly fragrant, bract convolute, elliptic, brown, densely hairy……...…5.10.10. *H. villosum*

4a. Flowers pure red or with pale pink……..……..... 5

4b. Flowers white or with pale yellow….. …….……...6

5a. Corolla red with whitish base and yellowish tips, tube equaling to the bract, 2-3 flowers per single bract, ovary green, *ca.* 2 mm……5.10.6. *H. rubrum*

5b. Corolla tube Crimson red, equal to or shorter than the bracts, 5-6 flowers per one bract; ovary pale yellow, 2.5-3 mm …….…...5.10.1. *H. coccineum*

6a. Rhizome white or creamy white inside ..…...……..……7

6b. Rhizome yellow, greyish yellow or yellowish green inside…….……...…. 8

7a. Spikes 10-17 cm long, leafy stem 1.2 - 2.0 m high, bract enclosing 3-9 successively opening flowers ……..……...5.10.3. *H. dekianum*

7b. Spike 40-60 cm long, leafy stems 2 - 3 m high, bract enclosing 2-4-flowers …….…..…5.10.8. *H. stenopetalum*

8a. Filament white, anther creamy white to pale yellow……..….....9

8b. Filaments reddish or pinkish yellow red, Anther orange or yellowish red……10

9a. Pseudostems 1-3 m high, leaves sessile, spikes 10-20 cm long, ellipsoid……..5.10.2. *H. coronarium*

9b. Pseudostem 0.7-1.5 m high, leaves sub-sessile spikes 8-20 cm long, oblong compact…….. 5.10.9. *H. thyrsiforme*

10a. Inflorescence 5-12 cm long, filament 5.5-5.6 cm long, anther orange red…….….5.10.4. *H. ellipticum*

10b. Inflorescences 15-20 cm long, filament c. 3 cm long, yellowish red……..……. 11

11a. Bracts oblong to ovate, 4 or 5-flowered, leaf blades elliptic-lanceolate or lanceolate ……..5.10.5. *H. flavescens*

11b. Bracts lanceolate, 1-flowered, leaf blade ovate-oblong to oblong……...5.10.12. *H. yunnanense*

5.10.1. *Hedychium coccineum* Buch.-Ham. ex Sm. In Rees Cyclop. 17: 5. 1811; Baker in Hook. f. Fl. Brit. Ind. 6: 231. 1892; T.L. Wu & K. Larsen in Z.L. Wu & P.H. Raven, eds. Fl. China 24: 370-377. 2000; N.P. Singh *et. al*. in Fl. Mizoram 1:34-85. 2002.

Photoplate-VIII (E-F)

Scientific name : *Hedychium coccineum* Buch.-Ham. ex Sm.

Local Name : Aidu-par-sen (L. Vanchhawng, 2013).

Common Name : Disney ginger, Salmon ginger, scarlet ginger-lily.

Locality : Found all over in Mizoram.

Altitude : 300 - 1500 m.

Habit : Perennial rhizomatous herb.

Habitat : Tropical and sub-tropical semi-evergreen forests.

Botanical Description : Pseudostems 1.5-2 m. *Leaves* sessile; *ligule* 1.2-2.5 cm; *leaf blade* narrowly linear, 25-50 x 3-5 cm, glabrous, base subrounded or attenuate, apex caudate-acuminate. *Spikes* cylindric; *bracts* oblong, 3-3.5 cm long, leathery, sparsely pubescent, rarely glabrous, 5-6-flowered. *Flowers* crimson red; *calyx ca.* 2.5 cm, sparsely pubescent especially at 3-toothed apex; *corolla tube* 2.5-2.7 cm long, equal to or slightly longer than calyx. *Lateral staminodes* lanceolate, *ca*. 2.3 cm; *labellum* orbicular, *ca.* 2 cm wide or rather small. *Filament ca.* 5 cm; anther 7-8 mm. *Ovary* sericeous, 2.5-3 mm. *Capsule* globose, *ca.* 2 cm in diam. *Seeds* red.

Phenology : Flowering : July - August
Fruiting : September - October

Ecological status : Full sun to part shade, moist, rich well-drained soil.

Taxonomical status : Common.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Clerodendrum bracteata, Hedychium gracilis, Amomum dealbatum, Albezia procera, Lantana camara, Emblica spicata, Ageratum conyzoides* and grass species.

Species examined : Mizoram, Haulawng, Lunglei Dist., *L. Vanchhawng & H. Lalramnghinglova* 42804 (MZU).

Distribution : The taxon is native to central and eastern Himalaya. Eastern India, Bangladesh, Nepal, Sri Lanka, Thailand and Vietnam. In India, *Hedychium coccineum* is found in North eastern states.

Uses : Not known, usually cultivated in gardens as an ornamentals.

5.10.2. ***Hedychium coronarium*** Koen. in Retz. Obs. Bot. 3: 73. 1783; Wight, Ic. t. 2010. 1853; Baker in Hook. f. Fl. Brit. Ind. 6: 225. 1892; Fischer in Gamble, Fl. Pres. Madras 3: 1039. 1957 (repr. ed); T.L. Wu & K. Larsen in Z.L. Wu & P.H. Raven, eds. Fl. China 24:370-377. 2000; H. Lalram. Ethn. Med. Pl. Mizoram 171. 2003.

Photoplate-VIII (I-J)

Scientific name : *Hedychium coronarium* Koen.

Local Name : Ai-lalnu (Lalramnghinglova, 2003).

Common Name : Butterfly Lily, Garland flower.

Locality : Cultivated in private gardens almost all over Mizoram.

Altitude : 600 - 1200 m.

Habit : A stout rhizomatous herb.

Habitat : Tropical and sub-tropical region.

Botanical Description : Pseudostems 1-3 m. *Rhizomes* thick, 2-3 cm, fleshy, yellow inside, roots many. *Leaves* sessile; *ligule* 2-3 cm, membranous; *leaf blade* oblong-lanceolate or lanceolate, 20-40 x 4.5-8 cm, abaxially glabrous, abaxially finely pubescent or thinly hairy, base acute, apex long acuminate. *Spikes* ellipsoid, 10-20 x 4-8 cm; *bracts* imbricate, ovate, 4.5-5 x 2.5-4 cm, 2- or 3- flowered. *Flowers* white, fragrant; *calyx ca.*

4 cm, split on 1 side; *corolla tube ca.* 8 cm, slender; *lobes* lanceolate, *ca.* 5 cm. *Lateral staminodes* oblong-lanceolate, *ca.* 5 cm; *labellum* white, pale yellow at base, obcordate, 4-6 x 4-6 cm. *Filament* white, *ca.* 3 cm; anther creamy white to pale yellow. *Ovary* sericeous.

Phenology : Flowering & Fruiting: June - December.

Ecological status : Grown in open and/or partial shaded areas on sandy loose soil.

Taxonomic status : Less frequent, cultivated.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : The plants being survived in cultivation in association with other plants, *viz.*, *Curcuma* spp., *Hedyotes scanders, Solanum* Sp.

Species examined : Mizoram, Pukpui-Lunglei, Lunglei Dist., *L. Vanchhawng & H. Lalramnghinglova* 42803 (MZU).

Distribution : This perennial ginger grows in the forests of China, Taiwan, Bhutan, Indonesia, India, Malaysia, Thailand, Vietnam, Australia, Sri Lanka and Hawaii (Christophe, 2012). In India, it is common in Assam, Meghalaya, Arunachal Pradesh, South India. In Mizoram, this taxon is cultivated in private homestead gardens in small populations only.

Uses : 1) The plant is cultivated for the fragrant white flowers as ornamental plant. In Hawaii, the flowers of this plant are used for making leis and also as a source of perfume.

2) Base of stem is used for swellings.

3) Rhizome is used as febrifuge and anti-rheumatic.

4) In Thailand, a decoction of the stem is gargled for Tonsillitis. It is used in the treatment of foetid nostrils. The flower is also eaten as vegetable.

Remarks : The fragrant flower is widely used for perfumes.

5.10.3. ***Hedychium dekianum*** Rao & Verma in Bull. Bot. Surv. Ind. 11: 122. F. 1-3. 1969 (1971), & 14; 129. 1972; Balakrishnan in Fl. Jowai. 2: 527. 1983; E. Sanoj, M. Sabu & T.R. Kumar, in J. Bot. Res. Inst. Texas 4(2): 633-639. 2010.

Scientific name : *Hedychium dekianum* A.S. Rao & D.M. Verma.

Local Name : Not available.

Common Name : Not available.

Locality : Dampa Tiger Reserve, Mamit District; Pualreng W.S., Kolasib District.

Altitute : 800 - 1500 m.

Habit : Rhizomatous perennial herb.

Habitat : Tropical semi evergreen forests.

Botanical Description : *Rhizomes* white inside, pale pink outside, faintly aromatic. *Leafy stem* 1.2-2.0 m high. *Leaves* sessile, lanceolate to oblong-lanceolate, subcaudate, 30-50 x 5.5-13.0 cm, appressed silky beneath; *ligule*1.0-4.0 cm, villous, pinkish, bilobed. *Spikes* 10-17 cm; *bract* oblong, closely convolute, 4-6 x 1.5-2.0 cm, pubescent, scarious-margined,

acute-obtuse, each bract enclosing 3-9 successively opening flowers; *bracteoles* ovate-oblong, 3-3.5 x 1-1.7 cm, pubescent. *Flowers* white with pale yellow blotch on lip, fragrant; *calyx* membranous, tubular, slightly shorter or longer than the bract, pubescent, 3-toothed, deeply split in one side; *corolla lobes* linear, 3.5-4.7 cm, exceeding the bracts. *Lateral staminode* spathulate, 2.5-3.6 x 1-1.6 cm; *lip* sub orbicular, bilobed, white with a pale yellow blotch at base, bilobed. *Stamen* 1-2 cm longer than the lip; *anther* linear, 1-1.2 cm. *Capsule* oblong cylindric, sparsely hair, 4-6 cm long, yellow green outside, orange inside. *Seeds* sub-globose, bright red.

Phenology : Flowering & Flowering : July - September.

Ecological status : Grown in loamy soil with rich humus under secondary forests, on open or partially shaded places.

Taxonomic status : Rare.

IUCN Category : This taxon has not yet been assessed for the IUCN Red List, 2014.

Associates : *Arisaema speciosum, Begonia roxburgnii, Blumea lanceolaria, Derris thyrsiflora, Phrynium capitatum* etc.

Species examined : Mizoram, Dampa Tiger Reserve, Mamit Dist., *L. Vanchhawng & H. Lalramnghinglova* 428900 (MZU).

Distribution : Native to Vietnam, China, Myanmar. In India, the plant is endemic in Jowai, Meghalaya; and Mizoram.

Uses : Crushed rhizome is applied on wounds and cuts (Kala, 2005).

5.10.4. ***Hedychium ellipticum*** Buch.-Ham. Ex Smith in Rees, Cyclop. 17: no. 2. 1811; Rosc. Scit. Pl. t. 55. 1826; Baker in Hook. f. Fl. Brit. Ind. 6: 228. 1892; Fischer in Rec. Bot. Surv. Ind. 12(2): 144. 1938; D.B. Deb, Fl. Tripura 2:377. 1983.

Photoplate-VIII (K-L)

Scientific name : *Hedychium ellipticum* Buch.- Ham. ex Smith.

Local Name : Not available.

Common Name : Shaving Brush Ginger, Rock Butterfly Lily.

Locality : Murlen N.P., Champhai District.

Altitude : 1000 - 1500 m.

Habit : Terrestrial herbs, rarely epiphytic.

Habitat : Sub-tropical evergreen and semi evergreen forests.

Botanical Description : The plant is about 1.4 m high. *Rhizome* thick, yellowish green outside, roots large, root hairs abundant. *Leafy stems* 70-120 cm long. *Leaves* 25-30 x 8-14 cm, sessile with upto 3 cm long petiole, oblong glabrous; *ligule* bright red. *Spikes* 5-12 cm long, cone like dense flowered; *bracts* 1.7-3 x 0.8-1 cm, navicular, green, 1-flowered. *Flowers* white turning yellow, fragrant; *calyx ca.* 2.5 cm long; *corolla tube* 3.0-3.5 5 cm long, oblanceolate or spathulate; *lip* 2.5-3 x 0.5 cm, oblong, cuneate, divided into two acute lobes with *ca.* 2 mm deep sinus, rarely notched, clawed with *ca.* 1.2 cm long. *Filaments* yellowish red, 5.5-5.6 cm; *anther* linear, orange yellow.

Phenology : Flowering & Fruiting: June - September.

Ecological status : The plant grows well in semi shaded; and prefers high level of water where it can be found growing on shaded mud slopes. The plant is adapted to sandy loam soils and prefers high fertility.

Taxonomical status : Frequent.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Tetrastigma serrulatum, Macaranga denticulate, Hedychium coccineum,* Bamboo Spp. & Grass Spp.

Species examined : Mizoram, Murlen N.P., Champhai Dist., *L. Vanchhawng & H. Lalramnghinglova* 42879 (MZU).

Distribution : This species is a native of Eastern Himalayas and North East India. It is found in Thailand, Nepal, Bhutan, Myanmar and Laos.

Uses : The plant is grown for their fragrant and showy flowers.

Remark : **First reported from Mizoram.**

5.10.5. ***Hedychium flavescens*** Carey ex. Rosc., Monandr. Pl. Scit. t. 50. 1824; Wight, Ic. t. 2008. 1853; Gamble, Fl. Pres. Madras 3: 1038. 1957 (repr. ed.); T.L. Wu & K. Larsen in Z.L. Wu & PH. Raven, eds. Fl. China 24: 370-377. 2000.

Photoplate-VIII (M-N)

Scientific name : *Hedychium flavescens* Carey ex Rosc.

Local Name : Aidu-par-eng (Lalramnghinglova & L. Vanchhawng, 2014).

Common Name : Yellow Ginger, Cream Garland-lily, Cream Ginger.

Locality : Murlen N.P., Champhai District.

Altitude : 600 - 1200 m.

Habit : Coarse perennial herb.

Habitat : Tropical and Sub tropical semi evergreen forests.

Botanical Description : *Pseudostems* 1-3 m in height. *Rhizomes* thick fleshy and erect, light greyish-yellow inside. *Leaves* sessile, slightly pubescent sheaths; *ligule* 3-5 cm long, membranous; *leaf blades* elliptic-lanceolate or lanceolate. *Inflorescences* oblong spikes, 15-20 cm, 3-6 cm wide; *bracts* imbricate, oblong to ovate, concave, 4 or 5-flowered; *bracteoles* tubular, membranous. *Flowers* creamy-white to pale yellow, fragrant with yellow stamens; *calyx* 3.5-4 cm, pubescent, approximately half the length of the corolla tube; *corolla tube* 7-8.5 cm, long and slender. *Lateral staminodes* wider than corolla lobes; *labellum* erect, creamy yellow with an orange patch at base, obcordate, apex 2-lobed. *Filament* linear, *ca.* 3 cm long, pinkish yellow; *anther* yellowish red. *Ovary* hairy; *stigma* funnel form. *Fruits* globose, three valves. *Seeds* numerous.

Phenology : Flowering : July & August.
Fruiting : September.

Ecological status : The plant grows under full or partial shade of rainforests, moist forests and in a rich moist soil along water courses.

Taxonomical status : Rare.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Alcornia tiliafolia, Macaranga indica, Aporusa octandra, Costus, speciosus, Dendrocalumus sp., Solanum indicum, Amomum dealbatum* etc.

Species examined : Mizoram, Murlen N.P., Champhai Dist., *L. Vanchhawng & H. Lalramnghinglova* 42882 (MZU).

Distribution : The plant is native to the eastern Himalayas, including Nepal and north-eastern India (Assam, Meghalaya and Sikkim). It is also found in the southern states of India *viz.* Kerala and Tamil Nadu; however, *H. flavescens* is now widely introduced and naturalized in various tropical countries.

Uses : 1) *H. flavescens* is best known as a spectacular flowering plant, introduced all over the world as an ornamental due to its beautiful and fragrant flowers. It is also used in 'lei making' (flower weaving) in Hawaii, and is popularly used in women's hair in other areas.

2) The chemical composition of the essential oils from the rhizomes of several *Hedychium* spp. were investigated including *H. flavescens* from southern India and the strongest activities were observed for the rhizome oil from *H. flavescens,* especially against *Salmonella typhi*, *Escherichia coli*, *Proteus vulgaris* and the fungi *Candida albicans* and *Candida glabrata* (Baby *et al.*, 2007).

Remark : **First reported from Mizoram.**

5.10.6. ***Hedychium rubrum*** A.S. Rao & D.M. Verma in Bull. Bot. Surv. Ind. 11(1&2): 120-128. 1969. **Photoplate-VIII (G-H)**

Scientific name : *Hedychium rubrum* A.S. Rao & D.M. Verma.

Local Name : Murlen-ai-par (Lalramnghinglova & L. Vanchhawng, 2014).

Common Name : Not available.

Locality : Murlen N.P., Champhai District.

Altitude : 600 - 1200 m.

Habit : Perennial rhizomatous herb.

Habitat : Temperate and Sub-tropical semi evergreen forests.

Botanical Description : *Rhizome* creeping, scaly, white inside, non aromatic. *Leafy stem* 0.5-1.2 m tall. *Leaves* sessile, lanceolate, 17-32 x 3-7 cm, subcaudate, upper surface glabrous, lower surface hairy along midrib; *ligule* 1-3.2 cm long, entire, pubescent, pinkish green. *Spike* 6-14 cm long; *rachis* villous; *bracts* 10-18, oblong, closely convolute, 3.5-4.7 x 1.5-2 cm, pubescent, purplish green, acute, 2-flowered; *bracteole* membranous, pink; *calyx* tubular, 2.4-2.8 cm long, 3-toothed, split on one side, pubescent, pale pink; corolla red with whitish base and yellowish tips. *Lateral staminodes* obliquely spathulate, red, slightly shorter than the lip, *ca.* 8 mm broad, apex rounded; *lip* suborbicular, red, shortly clawed, deeply bilobed. *Filament ca.* 4 cm long, red; *anther* linear, *ca.* 1 cm long, red. *Ovary* subglobose, *ca.* 2 mm, villous; *stigma* turbinate, hairy, green. *Capsule* subglobose or broadly ovoid,

subtrigonouspink red outside, orabnge inside. *Seeds* with aril subglobose, bright red, *ca.* 5 mm.

Phenology : Flowering & Fruiting: July - October.

Ecological status : Grown along the margin of tropical evergreen forests on a moist loamy soil. The plant is also found to grow with grasses species in an open space, fully or partially shaded.

Taxonomic status : Frequent.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Rubus ellipticus, Securinega virosa, Thunbergia grandiflora, Litsea cubeba, Maranta dichotoma, Imperata cyllindrica, Mikania micrantha, Callicarpa arborea* etc.

Species examined : Mizoram, Murlen N.P., Champhai Dist., *L. Vanchhawng & H. Lalramnghinglova* 42873 (MZU).

Distribution : In india, the plant is **endemic** to Meghalaya and Mizoram. It is distributed in Malaysia, Bangladesh, Myanmar.

Uses : The plant has ornamental characteristic, but no scientific report is available to validate its medicinal uses.

Remark : **First reported from Mizoram.**

5.10.7. ***Hedychium spicatum*** Buch.-Ham. Ex Smith in Rees Cyclop. 17: 3. 1811: Baker in Hook. f. Fl. Brit. Ind. 6: 227. 1892; H.J. Noltie, Fl. Bhutan 3(1): 203. 1994; T.L. Wu

& K. Larsen in Z.L. Wu & PH. Raven, eds. Fl. China 24: 372. 2000; N.P. Singh *et. al*. in Fl. Mizoram 1:34-85. 2002. **Photoplate VIII (O-P)**

Scientific name : *Hedychium spicatum* Buch-Ham.

Local Name : Ai-par-zum (L. Vanchhawng, 2014).

Common Name : Spiked Ginger Lily (English), Kapur-kachari (Hindi).

Locality : Murlen N.P., Champhai District.

Altitude : 800 - 1200 m.

Habit : Perennial rhizomatous herb.

Habitat : Sub-Tropical evergreen and semi-evergreen forests.

Botanical Description : *Pseudostems* 50-120 cm high. *Leaves* elliptic-oblong, 30-40 x 10-12 cm, apex acute-acuminate, upper surface glabrous, lower surface glabrous or sparsely hairy; *ligule* oblong, membranous, pubescent, apex emarginate or acute. *Inflorescence* a terminal spike, erect, 20-35 cm long; *bracts* folded, greenish, lanceolate-oblong, 2-4 x 1-2 cm, apex acute, glabrous or sparsely hairy; *bracteole* tubular, apex acute, membranous. *Flowers* white tinged yellow or reddish at base, fragrant; *calyx* tubular, apex acute to 3-lobed, glabrous or sparsely hairy; *corolla tube* 5-6 cm, slender, 3-lobed, apex hooded, yellowish. *Lateral staminodes* oblanceolate-oblong; *labellum* obovate, apex bilobed, each lobe elliptic, white with pale salmon red patch at base. *Filament* 2-2.5 cm, salmon red; *anther* salmon red. *Ovary*, 3-loculed, placentation axile, hairy. *Fruits* ellipsoid- oblong, 2-3 x 1-2 cm, hairy,

greenish, yellow, orange inside. *Seeds* numerous, ellipsoid-orbicular, reddish orange.

Phenology : Flowering : July - August.
Fruiting : September - November.

Ecological status : The plant grows well in moist, sunny position and wide range of climatic conditions forests. The plant prefers sandy loamy and clayey soil. It cannot grow in the shade and susceptible to frost.

Taxonomic status : Rare.

Status/Category : According to the threat status of the World Conservation Union (International Union for Conservation of Nature and Natural resources; IUCN) criteria, *Hedychium spicatum* has become **vulnerable** due to reduction in population of over 20% in the last ten years. It is also listed in the near **threatened** category of the essential oil bearing plants (Kemp, 2003; Samant and Palni, 2000).

Associates : *Macaranga indica, Meloccana baccifera, Mikania micrantha, Derris robusta, Chromolaena odorata* etc.

Species examined : Mizoram, Murlen N.P., Champhai Dist., *L. Vanchhawng & H. Lalramnghinglova* 42875 (MZU).

Distribution : It is distributed in sub-tropical region of Himalaya in the state of Assam, Arunachal Pradesh, Uttarakhand and other states of NE India like Sikkim, Nagaland, Meghalaya and Mizoram within an altitudinal range of 1000-3000 m. It is also found in the Himalayan region of Nepal, Bhutan and China.

Uses : 1) The essential oil extracted from the rhizomes of this plant has been in use traditionally for treating respiratory problems (like bronchitis and asthma), wounds, fever, cough, indigestion, hiccough, inflammation and certain other eye problems (Srimal *et al.*, 1984; Prakash and Singh, 2001).

2) The rootstock is carminative, stimulant, stomachic and tonic (Husain *et al.*, 1992).

3) The rhizomes are powdered and used as an antiseptic agent and as a poultice for various aches and pains (Bisht *et al.*, 2006).

4) Ginger lily is also helpful in treating liver complaints, indigestion and poor circulation due to thickening of the blood.

5) The crude extract of the rhizome has been used in the preparation of an anticancerous drug, PDMA 28 (Nayab *et al.*, 2004).

Remarks **:** The rhizome has been used in various traditions for treating numerous health conditions. According to books written by reknown Ayurvedic Physicians Charaka and Sushruta**, *H. spicatum* is an excellent remedy for treating respiratory illnesses like asthma and bronchitis**. The Ayurvedic healing system used this herb for curing respiratory problems, poor blood circulation, indigestion, wounds and inflammation. It was used as a natural remedy for treating diarrhea, vomiting, snake bite, fever and inflammation in the Traditional Chinese Medicine. The plant was used in the Tibetan

medicine for its heating potency and acrid taste and was also used as an effective insect repellant.

5.10.8. ***Hedychium stenopetalum*** Lodd., Bot. Cab. 20: t. 1902. 1833; Baker in Hook. f. Fl. Brit. Ind. 6: 231. 1894; K. Schum. in Engl. Pflanz. 4(46): 58. 1904; A.S. Rao & D.M. Verma, in Bull. Bot. Serv. Ind. 14(1-4): 133. 1972.

Photoplate IX (A-B)

Scientific name : *Hedychium stenopetalum* Lodd.

Local Name : Aidu-par-var (L. Vanchhawng, 2014).

Common Name : Slender petal Ginger, White star ginger.

Locality : Thenzawl, Serchhip District; Tanhril, Aizawl District Murlen N.P., Champhai Dist; Thorang W.S., Lunglei District.

Altitude : 500 - 900 m.

Habit : Rhizomatous perennial herb.

Habitat : Tropical and sub-tropical forests.

Botanical Description : *Stems* 2-3 m high. *Leaves* petiolate, blade lanceolate-oblong, 50-65 x 9-15 cm, upper surface glabrous, lower surface hairy. *Spike* terminal, 40-60 cm long, lax-flowered; *bracts* lax, folded, green, lanceolate to obovate, 3.5-4.5 x 1.3-1.5 cm, convolute, 2-4-flowered; *bracteoles* triangular, apex acute, membranous, pubescent. *Flowers* white with pale yellow blotch in mouth, fragrant; *calyx* equalling the bract; *corolla tube* 10-15 mm longer than the bract, *lobes* 4-5 cm long. *Lateral staminodes* narrowly oblanceolate, *ca.* 30 x 3.5 mm, notched;

labellum sub-orbicular to orbicular, 3-4.2 x by 2.5-3.4 cm, white with pale greenish patch at base; *lip* obovate, cuneate to a short claw, *ca.* 3 x 1-1.5 cm, deeply bilobed. *Filament* 5-6 cm long, yellowish; *anther* dorsifixed, *ca.* 1 cm long, yellowish. *Ovary* pubescent, 4-5 x 6-8 mm, 3-loculed, placentation axile. *Fruits* ovoid to oblong, *ca.* 3 x 1 cm, green, hairy. *Seeds* numerous, ellipsoid to sub-globose, reddish orange.

Phenology : Flowering : June & July.
Fruiting : August & September.

Ecological status : The plant grows well in semi-shade and direct sun in a rich moist, well-drained soil.

Taxonomic status : Common.

Status/Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Rhus semiliata, Etlingera liguiformis, Amomum dealbatum, Albizia procera, Lasianthus hirsutus* etc.

Species examined : Mizoram, Murlen N.P., Champhai Dist., *L. Vanchhawng & H. Lalramnghinglova* 42874 (MZU).

Distribution : It is native to India, Nepal, Bhutan, Myanmar, Thailand, Northern Vietnam. In India, the plant is found in Meghalaya, Arunachal Pradesh, Assam and Mizoram.

Uses : 1) The strong fragrant of the flower is used for mosquito repellant. The essential oil extract from the plant is also used for killing insects and termites (Sakhanokho *et al.*, 2013).

2) The villagers cultivate the plant for ornaments.

Remark : **First reported from Mizoram.**

5.10.9. ***Hedychium thyrsiforme*** Buch.-Ham. ex. Sm. in Rees Cyclop. 17. n. 4. 1811; Baker in Hook. f. Fl. Brit. Ind. 6: 230. 1892; Rao & Verma in Bull. Bot. Surv. Ind. 11(1-4): 132. 1972; Kumar, Zingib. Sikkim 56. 2001. **Photoplate IX (C)**

Scientific name : *Hedychium thyrsiforme* Buch-Ham ex-Smith.

Local Name : Ai-parbawr (Lalramnghinghlova & L. Vanchhawng, 2014).

Common Name : Pincushion Ginger, Garland Lily, Frilly White Ginger.

Locality : Dampa Tiger Reserve, Mamit District; Thorang W.S., Sairep Natural Forest, Lunglei District.

Altitude : 600 - 1200 m.

Habit : Aromatic rhizomatous perennial herbs.

Habitat : Temperate amd sub-tropical semi evergreen forests.

Botanical Description : *Pseudostem* 0.7-1.5 m high. *Leaves* subsessile, 30-50 x 8-12 cm, oblong or oblong-lanceolate, villous beneath. *Spikes* oblong, 8-20 cm long, very dense flowers or compact; *bract* 3-4 cm long, lower empty, ovate, the upper 2-flowered, convolute, cylindric, green. *Flowers* white, fragrant; *calyx* 2.5-3 cm; *corolla* tube 1-1.5 cm longer than

bracts; *lobes* 3-4 cm long. *Staminodes* 2-2.5 x 0.2 cm, linear; *lip* 2-2.5 x 1-5 cm, obovate, clawed with yellow blotchy at the base, deeply bifid into two acute lobes. *Stamens* 5-6 cm; *filament* 4.5-6.5 cm long, white; *anther* 0.8-1 cm, linear.

Phenology : Flowering : July - August.
Fruiting : August - September.

Ecological status : The plant grows in a humus rich well-drained soil in a sunny sheltered place.

Taxonomical status : Frequent.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Datura spp., Mikania micrantha, Solanum spp., Lantana camara, Ageratum conyzoides, Sida acuta* and grasses.

Species examined : Mizoram, Tanhril, Aizawl Dist., *L. Vanchhawng & H. Lalramnghinglova* 42839 (MZU).

Distribution : Native to humid forests the Himalayas in Nepal, Eastern India and Bhutan between 600 and 1200 m. It is also found in the Chittagong Hill Tracts of Bangladesh.

Uses : 1) An infusion of the leaves is used by *the Chakmas* for baths in the treatment of anemia.

2) Flavonoids isolated from the rhizomes of *H. thyrsiforme* are assayed for antioxidant and antitumor activities. (Jasril *et. al.,* 2003).

3) The most potent mosquito repellent oils were obtained from *H. thyrsiforme.* (Sakhanokho *et. al.*, 2013).

Remark : **First reported from Mizoram.**

5.10.10. ***Hedychium villosum*** Wall. in Roxb. Fl. Ind. 1: 12. 1820; Baker in Hook. f. Fl. Brit. Ind. 6: 228. 1892; Rao & Verma in Bull. Bot. Surv. Ind. 14(1-4): 131. 1972; Sanoj, Sabu & Pradeep in PhytoKeys 25: 75-85. 2013.

Key to the varieties

1a. Inflorescence 16.5-33 cm long, flower 4.7-5.2 cm long, pale yellow, highly fragrant; corolla tube 1.9-2.1 cm long, pale yellow, densely pubescent externally……..……..6.10.10a. *H. villosum var. villosum*

1b. Inflorescence 8.4-12.3 cm long, flower 11.8-12.2 cm long, white with red stamen, mildly fragrant; Corolla tube 5-5.2 cm long, creamy white, glabrous externally……...…6.10.10b. *H. villosum var. tenuiflorum*

5.10.10a. ***Hedychium villosum var. villosum*** Wall. in Roxb. Fl. Ind. 1: 12. 1820.

Photoplate IX (D-E)

Scientific name : *Hedychium villosum* Wall.

Local Name : Aihmul (Lalramnghinglova & L. Vanchhawng, 2014).

Common Name : Haired Ginger Lily, Hardy Ginger.

Locality : Sairep Natural Forest, Lunglei Distict; Murlen N.P., Champhai District; Sialsuk, Aizawl District; Keitum, Serchhip District.

Altitude : 500 - 1600 m.

Habit : Terrestrial or epiphytic perennial herbs.

Habitat : Sub-tropical evergreen or semi-evergreen forest.

Botanical Description : *Leafy shoots* 60-90 cm high, erect, slender. *Leaves* 8-12 in number, sessile; *ligule* single-lobed, oblong, membranous, tip acute; *lamina* 14-20 x 3.7-4.5 cm, elliptic lanceolate, dark green and glabrous above, pale green. *Inflorescence* 16.5-33 cm long, erect, cylindrical; *bract* one on each flower, convolute, elliptic, brown, densely hairy externally. *Flower* 4.7-5.2 cm long, pale yellow, highly fragrant; c*alyx* convolute towards the tip, membranous, hairs brown; obscurely 3-lobed at tip; c*orolla tube* 1.9-2.1 cm long, straight, exceeding the calyx and bract, pale yellow, densely pubescent externally, hairy internally. *Lateral staminodes* linear, straight, pale yellow, tip acute; *labellum* elliptic, narrow towards base, pale yellow, lobes tip acute. *Filament* 2.4-2.6 cm long, scarlet, straight; *anther* sagittate, brown, glabrous, pink, glabrous. *Ovary* oblong, pale green, densely pubescent externally; *style* filiform, white, glabrous; *stigma* cup-shaped, margin ciliate, exserted from anther. *Fruits* not seen.

Phenology : Flowering : February - April.
Fruiting : Not seen.

Ecological status : The plant is growing on tall trees or moist slopes and in rocky crevices.

Taxonomic status : Rare.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Clerodendrum bracteata, Amomum dealbatum, Piper diffusum, Hedychium coccineum, Lagerstroemia speciosa* etc.

Species examined : Mizoram, Sialsuk, Aizawl Dist., *L. Vanchhawng & H. Lalramnghinglova* 42836 (MZU).

Distribution : The taxon originated in China (Kress *et. al.,* 2002). The plant is distributed in Bangladesh, China, India and Myanmar from 660 to 1400 m (Wu and Larsen 2000). In India, it is found in the North eastern states of Arunachal Pradesh, Assam, Meghalaya and Mizoram.

Uses : Juice of crushed rhizome is taken as a remedy for asthma, cough, spasms and colic.

5.10.10b. ***Hedychium villosum*** *var.* ***tenuiflorum*** Wall. ex Baker, Fl. Brit. Ind. 6: 229. 1892; N.P. Singh *et. al*. in Fl. Mizoram 1:34-85. 2002. Sanoj, Sabu & Pradeep in PhytoKeys 25: 75-85. 2013. **Photoplate IX (I-J)**

Scientific name : *Hedychium villosum var. tenuiflorum* Wall. ex Baker

Local Name : Thing-ai-hmul (Lalramnghnglova & L. Vanchhawng, 2014).

Common Name : Sweet Reed Butterfly Ginger.

Locality : Murlen N.P., Champhai District; Zotuitlang, Darzo, Lunglei District.

Altitude : 500 - 1500 m.

Habit : Epiphytic perennial herbs.

Habitat : Tropical semi evergreen forest.

Botanical Description : *Rhizomes* pale green internally, slightly aromatic. *Leafy shoots* 66-70 cm high, slanting or erect. *Leaves* 5-10 in number, sessile; *ligule* single-lobed, oblong, pale pink, densely pubescent externally, tip acute, early dried off; *lamina* 34-40 x 8-9 cm, elliptic-lanceolate, dark green above, pale green below, glabrous. *Inflorescence* 8.4-12.3 cm long, erect, lax, cylindrical; *bract* 2.7-2.9 x 1.1-1.2 cm, one on each flower, convolute, lanceolate, easily dried before flowering, densely hairy. *Flower* 11.8-12.2 cm long, white with red stamen, mildly fragrant; c*alyx* pale green, pink tinged towards tip, densely pubescent externally, obscurely 2 or 3 –lobed; *corolla tube* 5-5.2 x 2-2.5 mm wide at mouth, straight, exceeding the calyx and bract, creamy white, glabrous externally, hairy internally. *Lateral staminodes* 3.3-3.5 x 0.1-0.15 cm, linear, straight, linear, tip acute; *labellum* 3.1-3.5 x 1.2-1.5 cm, boat-shaped; *stamen* 5.8-6.5 cm long. *Filament* 5.3-6.3 cm long, straight, red, light red towards tip. *Ovary* 2.5-3 x 2-2.5 mm, barrel-shaped, pale green, densely pubescent externally; *stigma* cup-shaped, margin ciliate, 2-5 mm. *Fruits* globular, sericeous, slightly angular.

Phenology : Flowering : September.
Fruiting : November.

Ecological status : This species is growing on rocks in moist climate.

Taxonomic status : Very rare.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Pricasma javanica, Actocarpus lakocha, Calamus erectus,* Mosses and grasses.

Species examined : Mizoram, Tanhril, Aizawl Dist., *L. Vanchhawng & H. Lalramnghinglova* 42859 (MZU).

Distribution : The plant is believed to be originated in Vietnam. It is distributed in North Eastern India, Bangladesh, northern Myanmar, southern Yunnan and Guangxi provinces of China, Thailand, Vietnam, and Malaysia from 600 to 1800 m (Wu and Larsen 2000).

Uses : Ornament.

5.10.11. *Hedychium wardii* C.E.C. Fischer in Kew Bull. 1936: 283. 1936; Rao & Verma in Bull. Bot. Surv. Ind. 14: 130. 1972; Balakrishnan in Fl. Jowai. 2: 526. 1983.

Photoplate IX (F-H)

Scientific name : *Hedychium wardii* C.E.C. Fischer.

Local Name : Ai-sawhthing (Lalramnghinglova & L. Vanchhawng, 2014).

Common Name : Ginger Lily (English).

Locality : Murlen N.P., Champhai District.

Altitude : 800 - 1500 m.

Habit : Rhizomatous perennial herb.

Habitat : Temperate grassland and tropical semi-evergreen forests.

Botanical Description : *Rhizomes* stout, pink, fleshy, aromatic. *Leafy stem* 0.7-1.5 m. *Leaves* sessile, oblong-lanceolate, caudate-acuminate, 30-45 x 6-9 cm,

appressed hairy beneath; *ligule* 4-8 mm; *sheath* pubescent. *Inflorescence ca.* 15 cm tall compact, cone-like; *bract* green, obovate oblong. *Flowers* bright yellow, fragrant; *corolla tube* 6.5-7.5 cm; *lobes* linear 2-3 cm. *Lateral staminode* spathulate, 1.8-2.5 x 1.0-1.6 cm; *lip* sub-orbicular, 2.2-3.0 x 2.5-3.2 cm, bilobed. *Filament* almost complete absence; *anther* effectively sessile at the base of the labellum giving the flowers a very distinctive appearance.

Phenology : Flowering & Fruiting : July - September.

Ecological status : Open or partially shady places of grassland and secondary forests or along forest margin amidst grasses. The plants thrive well in moist loamy soil with rich humus.

Taxonomic status : Frequent.

IUCN Category : This taxon has not yet been assessed for the IUCN Red List, 2014.

Associates : *Solanum khasianum, Costus speciosus, Bischofia javanica, Etlingera linguiformis* and other grass species.

Species examined : Mizoram, Murlen N.P., Champhai Dist., *L. Vanchhawng & H. Lalramnghinglova* 42867 (MZU).

Distribution : The taxon is native to North Eastern India *viz.* Arunachal Pradesh, Meghalaya and Mizoram.

Uses : Neither reported nor information has been collected so far.

5.10.12. ***Hedychium yunnanense*** Gagnep. in Bull. Soc. Bot. France 54: 164. 1907; T.L. Wu & K. Larsen in Z.L. Wu & PH. Raven, eds. Fl. China 24: 373. 2000.

Photoplate IX (K-M)

Scientific name : *Hedychium yunnanense* F. Gagnep.

Local Name : China-ai (Lalramnghinglova & L. Vanchhawng, 2014).

Common Name : Yunnan ginger lily.

Locality : Murlen N.P.; Champhai District.

Altitude : 600 - 1300 m.

Habit : Rhizomatous perennial herb.

Habitat : Sub-tropical evergreen or semi-evergreen forests.

Botanical Description : Pseudostems stout. *Rhizome* stout, yellow inside, yellowish brown outside; *Leave* glabrous, base attenuate into short petiole, apex caudate; *ligule* oblong, entire, 1.5-2.5cm, membranous; *leaf blade* ovate-oblong to oblong, 20-40 x *ca.* 10 cm. *Spikes* up to 20 cm; *bracts* lanceolate, 1.5-2.5 cm, glabrous, 1-flowered, margin involute; *calyx* 1.7-2.8 cm, apex obtusely 3-toothed, ciliate; *corolla tube* 3.5-5 cm, slender; *lobes* linear, 2.5-3 cm. *Lateral staminodes* oblong-linear, shorter and wider than corolla lobes, base narrowed; *labellum* obovate, *ca.* 2 cm. *Filament* yellowish red, 3.5-4 cm; *anther* red, 1-1.2 cm. *Ovary* pilose; *stigma* ciliate. *Seeds* many, aril red.

Phenology : Flowering : July - August.
Fruiting : Not seen.

Ecological status : Grown in loamy soil with rich humus under evergreen or semi-evergreen forests.

Taxonomic status : Very rare.

Status/Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Lindernia ruelloides, Mikania micrantha, Gmelinia arborea, Callicarpa arborea, Amomum dealbatum, Hedychium rubrum, Melocanna baccifera* and Grassses.

Species examined : Mizoram, Murlen N.P., Champhai Dist., *L. Vanchhawng & H. Lalramnghinglova* 42876 (MZU).

Distribution : Native to Vietnam, China, N.E. Indian states.

Uses : Grown for their fragrant and showy flowers.

Remark : **First reported from Mizoram.**

5.11. KAEMPFERIA Linn. Spec. pl. 2. 1753 & Gen. ed.5.3.1754; Benth. in Benth. & Hook. f. Gen. Pl. 3: 641. 1883; Schum. K. in Engl. Pflan. 20:64. 1904; Mitra, Fl. Pl. East. Ind. 1: 244.1958; Dassanayake, Fl. Ceylon 4: 508.1983; Deb, Fl. Tripura 2:378. 1983; Noltie, Fl. Bhutan 3(1): 224.1994.

Low aerial stemless or rarely very short stemmed herbs with a few leaves. *Rhizome* often tuberous. *Leaves* few, linear-lanceolate. *Inflorescence* borne terminally on the leafy stem or on a separate branch of the rhizome and not contemporaneous with the leaves. *Flowers* spirally arranged , borne singly on the main axis, each in the axil of a bract; *bracts* spirally arranged, mature from base to top; *bracteoles* small, bifid, or sometimes split on the

base; *calyx* tubular, unilaterally split, shorter than as long as the corolla tube; *corolla tube* as long as the calyx tube or much longer; *lobes* equal, linear lanceolate, usually spreading. *Lateral staminodes* petaloid, flat, broad, long elliptic or obovate, usually resembling the labellum and also clawed; *labellum* deeply bilobed, showy, large. *Stamen* with exceedingly short filament; *anther* sessile, crest, petaloid. *Ovary* 3-celled, with many ovules in each cell; *style* long, filiform; *stigma* turbinate. *Fruit* usually a globose or oblong globose capsule. *Seeds* with small comb like aril.

11 species in India (Deb, 1983).

Key to the species of Mizoram *Kaempferia*

1a. Inflorescences borne terminal on pseudostems, enclosed by imbricate leaf sheaths, 2-3 flowered ……5.11.1. *K. pulchra*

1b. Inflorescences on separate shoots arising from rhizomes, appearing before pseudostems, 4-6 flowered…….……5.11.2. *K. rotunda*

5.11.1. ***Kaempferia pulchra*** Ridl. J. Asiat. Soc. Bengal 32: 107. 1899; Holt. Gard. Bull. Singapore 13: 122. t. 15. 1950; K. Schum. in Engler, Pflan. 4: 79. 1904; Y.K. Kam, Notes Roy. Bot. Gard. Edin. 38(1): 4. 1980; K. Larsen *et al.*, Gingers Pen. Malaya and Sing. 11.1999. **Photoplate X (A-C)**

Scientific name : *Kaempferia pulchra* Ridl.

Synonym : *Kaempferia elegans*Wall.

Local Name : Not available.

Common Name : Peacock ginger, Bronze peacock ginger, Resurrection lily.

Locality : Cultivated in Home garden at Mamit, Lunglei and Aizawl.

Altitude : 400 - 800 m.

Habit : Rhizomatous perennial herbs.

Habitat : Sub-tropical areas.

Botanical Description : Plant 12-18 inch high. *Rhizomes* tuberous, fragrant; spreading flat on ground. *Leaf* ovate; *lamina* variegated with pale green and dark green on above, pale green below; glabrous above, pubescent below. *Inflorescences* terminal on pseudostems, enclosed by imbricate leaf sheaths; *bracts* lanceolate, *ca.* 2.5 cm; *calyx* equaling bracts; *corolla* purple, linear, *ca.* 1.0 cm. *Lateral staminodes* obovate-cuneate, *ca.* 1.2 cm. *Fruit* not seen.

Phenology : Flowering : June - September.
Fruiting : Not seen.

Ecological status : Low growing plants under fully shaded or partially shaded areas in tropical region. Well-drained, organically enriched soil is best suited for the plant. During winter the plant remained dormant and started to re-appear in spring.

Taxonomical status : Frequent.

IUCN Category : The taxon has not been evaluated the taxon against the criteria as described in IUCN, 2014.

Associates : *Hedyotes scandens, Lobelia angulata, Centella asiatica, Borassus flabellifer, Erianthus longiseosus, Mikania micrantha* etc.

Species examined : Mizoram, Serkawn, Lunglei Dist., *L. Vanchhawng & H. Lalramnghinglova* 42807(MZU).

Distribution : The plant native to Thailand and Indonesia. It is also found in tropic and sub-tropical region of India, Burma and other S.E Asian countries.

Uses : It is cultivated in a garden for ornament.

5.11.2. ***Kaempferia rotunda*** Linn. Spec. Pl. 1: 3. 1753: Roxb. Asiat. Res. 11: 327. 1810 & Fl. Indica 1: 15. 1820; Baker in Hook. f. Fl. Brit. Ind. 6: 222. 1890; K. Schum. in Engler, Pflan. 4(46): 87. 1904; Ridley, Fl. Malay. Penin. 4: 246. 1924; Fischer in Gamble, Fl. Pres. Madras 8: 1484. 1928; Rao & Verma, Bull. Bot. Surv. Ind. 14: 124. 1972; N.P. Singh *et. al*. in Fl. Mizoram 1:34-85. 2002; M. Sabu, Zingib. Cost. South Ind. 215. 2006. **Photoplate X (D-F)**

Scientific name : *Kaempferia rotunda* Linn.

Local Name : Tuk-tin-par (Mizo).

Common Name : Indian crocus, Peacock ginger (English), Bhuyichampa (Hindi)

Locality : The plant is found throughout Mizoram both in wild and cultivation.

Altitude : 400 - 1200 m.

Habit : A stemless rhizomatous herb.

Habitat : Tropical and sub-tropical semi evergreen forests.

Botanical Description : *Rhizomes* with tuberous roots. *Leaves* 2-4, erect; *ligule* broadly triangular, 3-4 mm; *petiole* 1-2 cm, channeled; *leaf blade* usually

variegated dark and pale green on both sides of midvein, abaxially tinged purple, lanceolate-oblong, 17-27 x 7.5-9.5 cm. *Inflorescences* on separate shoots arising from rhizomes, appearing before pseudostems, sessile or shortly pedunculate, 4-6-flowered; *bracts* purple-brown; *bracteoles ca.* 2.3 cm, apex 2-toothed; *calyx* 4.5-7 cm, split on 1 side, apex 3-toothed; *corolla* tube equaling calyx. *Lateral staminodes* erect, white, lanceolate, *ca.* 5 x 1.7 cm, apex acute; *labellum* lilac, suborbicular, apically 2-cleft to base; *lobes* downcurved, *ca.* 3.5 x 2 cm, apex acute. *Anther* connective appendage erect, 2-cleft, fishtail-like. *Ovary* 4-6 mm, hairy.

Phenology : Flowering : April - June.
Fruiting : Not seen.

Ecological status : Grown under wet and humid areas with rich loamy soil having good drainage is ideal for the plant. Laterite soil with heavy organic manure application is also well suited. It is also cultivated as ornamental plant in home garden.

Taxonomical status : Rare.

IUCN Category : The taxon has not been evaluated the taxon against the criteria as described in IUCN, 2014.

Associates : Grows under shrub as undergrowth. The plant is also found under the shade of Bamboo sp.

Species examined : Mizoram, Sihphir, Aizawl Dist., *L. Vanchhawng & H. Lalramnghinglova* 42834(MZU).

Distribution : The plant is native to China, India, Nepal, Bangladesh, Taiwan, Indonesia, Malaysia, Myanmar, Sri Lanka, and Thailand where it is found in open grasslands. It is generally found in tropics and sub-tropics of Asia and Africa; and cultivated in all tropical countries. This taxon is distributed from India through Sri Lanka, southern China, Indochina, Malay Peninsula and Java.

Uses : 1) The tuber is used to treat abdominal illness, gastric complaints. The rhizome is used to treat stomach-ache, and is also used for cosmetics. The leaves are used as body lotion (Sirirugsa, 1997).

2) Used as ornamental plant for the flowers coming out of the leafless rhizome in blooming season (Borah *et. al.*, 2012).

3) Rhizome juice is also given in gastric pain; with little salt given in flatulence. Paste of the tuber along with other plant is given in scabies (Yusuf *et. al.,* 2009).

4) Rhizomes of *Kaempferia rotunda* is used as an anthelmintic against the worms (Agrawal *et. al.*, 2011).

5) The decoction of rhizome is applied to wounds for rapid coagulation of blood (Nadkarni, 1998).

Remark : The species is becoming overexploited and facing extinction (Swapna *et. al.*, 2004).

5.12. MANTISIA Sims in Bot. Mag. t. 1320. 1810; Baker in Hook. f. Fl. Brit. Ind. 6: 200. 1890; Mitra, Fl. Pl. E. Ind. 1: 251. 1958; A.S. Rao & D.M. Verma, in Bull. Bot. Surv. Ind. 14(1-4): 114-143. 1972.

Perennial herbs with short creeping rhizome. *Leafy stem* short. *Stem* scape like, sheath bearing with small leaves which apically somewhat with tail like coiled appendage. *Leaves* oblong-lanceolate. *Inflorescence* arising from the base of the plant; *panicle* laxly-fid; *bracts* at the forks membranous, coloured; *calyx* tubular, companulate, shortly 3-lobed; *corolla tube* very narrow with 3 ovate violet segments, the odd of which more or less large, concave, erect in bud enclosing other two segments. *Lateral staminodes* long, linear, arising on either side of the filament, slender, spathulate; *labellum* yellow, curved downward. *Filaments* long, curved; *anther* linear oblong, wide winged. *Ovary* 1-celled; *ovules* numerous, parietal; *style* filiform, placed in groove of the filament; *stigma* turbinate or cup shaped, margin finely ciliated. *Fruit* capsular or soft berry, globose, dehiscising at the apex. *Seeds* many, minute, oblong.

Key to the species of Mizoram *Mantisia*

1a. Peduncles ca. 5 cm long; bracts pale violet, staminodes attached to the filament ca. 3 mm above the corolla mouth……5.12.1. *M. spathulata*

1b. Peduncles 1.5-3 cm long, bracts yellowish green, staminodes attached to the filament ca. 5 mm above the corolla mouth ……..5.12.2. *M. wengeri*

5.12.1. ***Mantisia spathulata*** Schult. in R & S. Mant. 1: 49. 1822; *Globba spathulata* Roxb. Fl. Ind. 1: 83. 1820; A.S. Rao & D.M. Verma, in Bull. Bot. Surv. Ind. 14(1-4): 114-143. 1972. **Photoplate X (G-J)**

Scientific name : *Mantisia spathulata* Schult.

Local Name : Ai-ting (Mizo).

Common Name : Dancing girl (English).

Locality : Durtlang, Aizawl District; Reiek; Mamit District.

Altitude : 600 - 1300 m.

Habit : Epiphytic rhizomatous herb.

Habitat : Tropical and sub-tropical forests.

Botanical Description : *Stems* 30-60 cm high, purplish at base. *Leaves* 10-25 x 3.5-5.5 cm, glabrous, purplish beneath when young, becoming green when mature. *Panicles* 10-25 cm long, on *ca.* 5 cm long peduncle; branches numerous, approximate, villous; *bracts ca.* 1 cm long, pale violet; *bracteoles ca.* 7 mm long, pale violet. *Flowers* violet; *calyx ca.* 6 mm long, *lobes* ovate, acuminate, *ca.* 2 mm long; *corolla* hairy outside, tube 15-18 mm long, *lobes* 4-5 mm long, dorsal *ca.* 4 mm broad, laterals *ca.* 3 mm broad. *Staminodes* attached to the filament *ca.* 3 mm above the corolla mouth; *lip* obovate, 6-8 mm long, yellow, base cuneate, hairy, apex divided into two 2-3 mm broad lobes. *Filament* 15-17 mm long, curved; *anther ca.* 2 mm long, wings semi-lunar, *ca.* 1.5 mm long long, crest quadrate, *ca.* 0.8 mm long. *Ovary* oblong, pale violet.

Phenology : Flowering : May - July.
Fruiting : June - August.

Ecological status : Grown on moist rocky slope or bark of giant trees.

Taxonomic status : Very rare, critically endangered.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : Grows on the rocky surface along with mosses and grass species.

Species examined : Mizoram, Reiek, Aizawl Dist., *L. Vanchhawng & H. Lalramnghinglova* 42845 (MZU).

Distribution : The plant is originated in Bangladesh and North East India and they are presently found in these two regions only.

Uses : *Mantisia spathulata* is used by locals for curing broken bones and dysentery.

Remarks : *Mantisia spathulata* is very rare in Mizoram; they are found only in a small population at Lunglawn and Sethlun, Lunglei District. The species is Critically Endangered due to the destruction of their habitat.

5.12.2. ***Mantisia wengeri*** Fischer in Kew Bull. 1931: 283. 1931; A.S. Rao & D.M. Verma, in Bull. Bot. Surv. Ind. 14(1-4): 114-143. 1972. **Photoplate XI (A-B)**

Scientific name : *Mantisia wengeri* C.E.C. Fischer.

Local Name : Ai-ting (Mizo).

Common Name : Dancing girl (English).

Locality : Lunglawn and Sethlun, Lunglei District.

Altitude : 800 - 1500 m.

Habit : Epiphytic rhizomatous perennial herb.

Habitat : Sub-tropical semi evergreen forests.

Botanical Description : *Stems* upto 1 m high. *Leaves* 8-20 x 2-3.5 cm, glabrous or ciliolate along nerves above; *sheaths* puberulus. *Panicles* 1.5-3 cm long; *peduncles* 1.5-3 cm long, glabrous or puberulus; *bracts* suborbiculate, *ca.* 1 cm long, glabrous or puberulus, yellowish green; *bracteoles* 5-8 mm long. *Flowers* yellow or yellowish brown; *calyx* 7-8 cm long; *corolla* yellow, hairy, *corolla tube ca.* 17 mm long, *corolla lobes* 4-5 mm long. *Staminodes* attached to the filament *ca.* 5 mm above the corolla mouth, 8-13 mm long; *lip* obovate, cuneate, 13-15 mm long, yellow, deeply bifid. *Filament ca.* 15 mm long, curved; *anther* wings, oblong. *Ovary* oblong. *Seeds ca.* 1.5 mm long

Phenology : Flowering : May - June.
Fruiting : July - August.

Ecological status : The species grown on a rocky surface or on the bark of a big tree.

Taxonomic status : Very rare, critically endangered (CR).

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : *Erianthus longiseosus*, *Eupatorium odoratum*, Grass *spp*. and mosses.

Species examined : Mizoram, Sethlun, Lunglei Dist., *L. Vanchhawng & H. Lalramnghinglova* 42853(MZU).

Distribution : *Mantisia wengeri* is found in N.E. India and Myanmar. The plant is **endemic** to Mizoram, N.E. India.

Uses : The rhizome of *Mantisia wengeri* has been used as a remedy for bone fracture and gastrointestinal ailments by a local people.

Remarks : The rarity of *Mantisia wengeri* has reached a critical level and has been included in the national priority list for its recovery by Department of Biotechnology, New Delhi, India (Ganeshaiah, 2005).

5.13. RHYNCHANTHUS Hook. f. in Bot. Mag.112: t. 6861. 1885; Baker in Hook. f. Fl. Brit. Ind.6: 257. 1890; K. Schum, in Engl. Pflan.4: 376. 1904; Fischer, Kew Bull. 203. 1932; A. S. Rao and D. M. Verma, Bull. Bot. Surv. Ind. 14: 140. 1972; S. Tripathi and V. Prakash, Ind. J. For. 21(4): 333. 1998; T.L. Wu & K. Larsen in Z.L. Wu & P.H. Raven, eds. Fl. China 24: 346-347. 2000.

Rhizomes tuberous. Pseudostems leafy. *Leaves* sessile or shortly petiolate; *leaf blade* oblong-lanceolate or elliptic-oblong. *Inflorescence* a terminal spike, few flowered; *bracts* large, each sub-tending 1 sessile flower; bracteole small, tubular. *Flowers* yellowish to red; *calyx* tubular, split to above middle on 1 side, apex minutely toothed; *corolla tube* subcylindric; lobes erect, ovate-lanceolate or lanceolate, central one larger than lateral ones. *Lateral staminodes* absent; *labellum* reduced to a tooth at base of filament or absent. *Filament* exserted above corolla, long, boat-shaped, margin incurved; *anther* locules parallel, without connective crest; connective without appendage or spur. *Ovary* 3-loculed; *ovules* many per locule, superposed. *Stylodes* 2, subfusiform. *Capsule* unknown.

5.13.1. *Rhynchanthus longiflorus* Hook. f. in Bot. Mag.112: t. 6861. 1885; Baker in Hook. f. Fl. Brit. Ind.6: 257. 1890; K. Schum, in Engl. Pflan.4: 376. 1904; Fischer, Kew Bull. 203. 1932; A. S. Rao and D. M. Verma, Bull. Bot. Surv. Ind. 14: 140. 1972; S. Tripathi and V. Prakash, Ind. J. For. 21(4): 333. 1998; M. G. Prasanthkumar *et al.*, in Current Sc. 88(6): 977-980. 2005. **Photoplate XI (C-D)**

Scientific name : *Rhynchanthus longifloras* Hook.f.

Local Name : Ai-senhri (Lalramnghinglova, 2014).

Common Name : Not available.

Locality : Phawngpui N.P., Lawngtlai District; Sairep Natural Forest, Lunglei District.

Altitude : 1000 - 1500 m.

Habit : Epiphytic, perennial rhizomatous herb.

Habitat : Sub-tropical wet evergreen moist forests.

Botanical Description : *Rhizome,* ovate, faintly aromatic with membranous scale leaves, arranged in a single linear row on tree trunks. *Leafy shoot* 60-100 cm long, drooping. *Leaves* 10-12 in number, sessile, ligulate; *ligule* 1.2 mm long, entire, greenish, glabrous; *lamina* 16-22 x 4-6 cm, glossy, dark green on the upper side, lower side pale green, both surfaces glabrous. *Inflorescence* a terminal, lax, unbranched spike; *bracts* 5-6 in number, oblong–lanceolate, bright red, glabrous, 1-flower; *bracteoles* 1 cm long, tubular, encircle the ovary, translucent orange. *Flowers* 5-6 in an inflorescence, arranged in two rows; *calyx* tubular, translucent orange; *corolla tube* 2-2.5 cm long, shorter than the calyx, reddish. *Filament* 4.8-5 cm long bright yellow towards the tip, dark violet towards the base; *anther* 0.8-0.9 cm long, orange. *Ovary* 0.2 cm in diameter, tri-locular with numerous ovules on swollen axile placenta; *stigma* cup-shaped, glabrous. *Seeds* cylindrical, 0.5 x 0.1 cm, greenish white, fine hairy.

Phenology : Flowering : September.
Fruiting : Not seen.

Ecological status : Growing as epiphyte on large tree trunks in wet evergreen and tropical moist forests.

Taxonomic status : Critically endangered.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : Grows on tree trunk and forks of trees, which are also heavily loaded with members of Araceae, Gesneriaceae, mosses and ferns.

Species examined : Mizoram, Pawngpui N.P. Lawngtlai Dist., *L. Vanchhawng & H. Lalramnghinglova* 42863(MZU).

Distribution : The species is distributed in North East India and Myanmar. But the present status of this species is not clearly recorded from Myanmar (Prasantkumar *et. al.*, 2005). Kew Royal Botanical Gardens also collected this species from New Guinea.

Uses : Ornamental.

Remarks : In Mizoram, this species is very rare, critically endangered. The major threat to *R. longiflorus* is habitat destruction due to anthropogenic intervention of shifting cultivation called 'Jhumming' or jhum cultivation.

5.14. ZINGIBER Boehm. In Ludwig, Defin. Gen. Pl. 89. 1760; Roxb. Asiat. Res. 11: 345. 1810, Fl. Indica 1: 46. 1820; Benth. & Hook. f. Gen. Pl. 3: 646. 1883; K.

Schum. in Engler, Pflan. 4(46): 165. 1904; Holtt. Gard. Bull. Sing. 13: 48. 1950; R.M. Sm. Note Roy. Bot. Gard. Edin. 45: 409. 1989; T.L. Wu & K. Larsen in Z.L. Wu & P.H. Raven, eds. Fl. China 24: 323-333. 2000; M. Sabu, Zingib. Cost. South Ind. 226. 2006.

Rhizomes thick, branched, tuberous, highly aromatic. *Pseudostems* erect, leafy, 1-2 m tall. *Leaves* sessile or shortly petiolate, distichous, held in plane parallel to rhizome; *ligule* short to long, entire or deeply bilobed; *petiole* swollen, cushion-like; *lamina* oblong, lanceolate, or linear. *Inflorescences* conical, arising from rhizomes on peduncle clothed with scale-like sheaths, rarely breaking through leaf sheaths without peduncle; *peduncle* short or long, usually clothed with sheaths; *bracts* large, fleshy, closely imbricate, green or other color, 1-flowered, persistent, fragile, short lived flower; *bracteoles* one to each flower, facing the bract, split to the base, persistent, not tubular. *Calyx* tubular, cylindric, split on 1 side, apex 3-toothed, usually shorter than the bracteoles, but sometimes longer. *Corolla tube* cylindric, slender; central lobe white or cream, usually wider than lateral lobes. *Labellum* deeply 3-lobed or rarely the side lobes fused with the mid-lobe. *Lateral staminodes* absent or if present small, adnate to labellum, forming a 3-lobed labellum; central lobe retuse or cleft at apex. *Filament* short; *anther* long, narrow, connective appendage at the tip, beak like, prolonged into slender, curved, enclosing the upper part of the style. *Ovary* glabrous or hairy, 3-loculed; ovules numerous per locule; placentation axile. *Style* slender, extending beyond anther locules; stigma not expanded. *Fruit* fleshy when fresh, leathery when dry, enclosed within persistent bract and bracteoles, dehiscing loculicidally, turning dark red at maturity. *Seeds* many, ellipsoid or globose, black, covered by aril; aril white, margin irregularly lacerate.

Key to the species of Mizoram *Zingiber*

1a. *Plants* upto 1m tall, *leaves* linear lanceolate, tapering gradually at the top, glabrous along mid-rib beneath…….5.14.2. *Z. officinale*

1b. *Plants* upto 1m-2.5m tall, *leaves* oblong-lanceolate, pubescent along midrib beneath…….....2

2a. *Corolla tube* equal to the length of the bract, *bract* ovate lanceolate pink in color ……5.14.1. *Z. ligulatum*

2b. *Corolla tube* shorter than the bract, *bract* ovate oblong, red in colour……....3

3a. *Spikes* ellipsoid, *flowers* yellow……5.14.3. *Z. purpureum*

3b. *Spikes* sub-globose, *flowers* red……..5.14.4. *Z. rubens*

5.14.1. ***Zingiber ligulatum*** Roxb. Asiat. Res. 11:348.1810 & Coromandel Pl. 3. t. 253. 1828; Baker in Hook. f. Fl. Brit. Ind. 6: 245. 1892. **Photoplate XI (E-G)**

Scientific name : *Zingiber ligulatum* Roxb.

Local Name : Not available.

Common Name : Not available.

Locality : Pualreng W.S., Kolasib District; Dampa Tiger Reserve and Dampui Reserve Forest, Mamit District.

Altitude : 500 - 1000 m.

Habit : Rhizomatous perennial herb.

Habitat : Tropical evergreen and semi-evergreen forests.

Botanical Description : Plants up to 1.0-1.2 m high. *Rhizome* pale yellow, elongated with numerous root hairs. *Leafy stem ca.* 2 ft. *Leaves* 20-30 x 6-8 cm,

glabrous beneath, oblong-lanceolate, dark green above paler below; *bracts* pink outer ovate inner lanceolate. *Corolla segments* pink; *corolla tube* as long as the bract; *lip* as long as the corolla-segments, obovate-cuneate yellowish-white, basal auricles small ovate; *stamen* yellow, shorter than the lip. *Capsule* oblong, *ca.* 3 cm, bright red inside. *Seeds* blackish-brown, with a nearly complete white aril.

Phenology : Flowering : June - August.
Fruiting : September - October.

Ecological status : Grown in a well drained soil rich in humas. The plant prefers shady atmosphere for better growing and development.

Taxonomic status : Rare.

IUCN Category : IUCN rated *Zingiber ligulatum* as Data Deficient with the 'Unknown provenance' and 'Uncertain taxonomic status' tags.

Associates : *Amomum dealbatum, Ardisia colorata, Alpinia bracteata, Chromolaena odorata, Mikania micrantha, Hedychium spp.*

Species examined : Mizoram, Bukpui, Kolasib Dist., *L. Vanchhawng & H. Lalramnghinglova* 42847(MZU).

Distribution : The species is reported to occur in East India and Myanmar (Govaerts 2004). It is also found in Coromandel Coast in Southern India (Karthikeyan 1996, Kress *et. al.*, 2003).

Uses : In Thailand, the species is traditionally used as anti-inflammatory.

5.14.2. ***Zingiber officinale*** Rosc. in Trans. Linn. Soc. 8: 348. 1807; Baker in Hook. f. Fl. Brit. Ind. 6: 248. 1892; K. Schum. in Engler, Pflan. 4(46): 170. 1904; A.S. Rao & D.M. Verma, Bull. Bot. Surv. India 14: 137. 1972; T.L. Wu & K. Larsen in Z.L. Wu & PH. Raven, eds. Fl. China 24: 370-377. 2000; S. Kumar, Zingib. Sikkim 71. 2001; N.P. Singh *et. al*. in Fl. Mizoram 1:34-85. 2002; H. Lalram. Ethn. Med. Pl. Mizoram 229. 2003; M. Sabu, Zingib. Cost. South Ind. 241. 2006.

Photoplate XI (K-L)

Scientific name : *Zingiber officinale* Roscoe.

Local Name : Sawhthing (Mizo).

Common Name : Ginger (English), Adi (Hindi).

Locality : Cultivated in a larger scale throughout Mizoram.

Altitude : 400 - 1600 m.

Habit : Herbaceous rhizomatous perennial.

Habitat : Tropical and subtropical regions.

Botanical Description : A perennial herb to 1 m tall. *Rootstock* stout, horizontal; *rhizomes* aromatic, pale yellow inside bearing many sessile tubers. *Leaves* 15-30 x 1.5-2.5 cm, sessile on sheaths, linear lanceolate, tapering gradually at the top, glabrous or puberulous along mid-rib beneath. *Spikes* 5-7 x 2-3 cm, cylindrical; *bracts* 2.5-3.0 cm long, scarious, green. *Flowers* longer than the bract, yellowish-green, cylindrical spike, *calyx* united, 3-toothed at apex; *corolla* lobes 3, lanceolate, green; *lip* 3-lobed, purplish, spotted with yellow; *labellum* more or

less round, dark purple; fertile stamen. *Ovary* inferior, 3-chambered, glabrous; *stigma* white, sub-globose. *Fruits* oblong. *Seeds* globose.

Phenology : Flowering & Fruiting : July - November.

Ecological status : Ginger is a warm-season crop adapted for growth in tropical and subtropical regions.

Taxonomic status : Very common, largely cultivated.

IUCN Category : This species has not yet been assessed for the IUCN Red List, 2014.

Associates : Cultivated in *Jhum* lands monoculturally, or sometimes under shades of *Aleurites Montana* or *Artocarpus heterophyllus.* It is also extensively cultivate in rice fields (Lalramnghinglova, 2003).

It can be grown in areas that experience light frosts as long as the rhizomes are not exposed to freezing temperatures. Ginger grows well in humid climate where it can absorb more sunlight (Amiril, 2006), but is also adapted to partial shade when grown in intercropping systems. Ginger requires a deep (25-40 cm), rock-free, sandy loam soil, high in organic matter with adequate drainage that allows for proper hilling of the crop (Valenzuela, 2011).

Species examined : Mizoram, Hauruang, Lunglei Dist., *L. Vanchhawng & H. Lalramnghinglova* 42808 (MZU).

Distribution : While the origin of ginger is uncertain, it is indigenous to the tropics, and some consider it to be a native of Southeast Asia (Valenzuela, 2011). Dahlgren *et. al.* (1985) considered it to be

originated from eastern India. Ginger is not known to occur in the truly wild state and is believed to have originated in Southeast Asia, but was under cultivation from ancient times in India as well as in China (Teuscher 2006; Langner *et. al.*, 1998; Germer *et. al.*, 1997). *Zingiber officinale* is widely distributed to tropical Asia (Kritikar and Basu, 2007). The plant is grown throughout South-eastern Asia, China and in parts of Japan, Austria, Latin America, Jamaica and Africa (Hasan *et. al.*, 2012).

Ginger is cultivated in most of the states in India. However, states namely Karnataka, Kerala, Meghalaya, Arunachal Pradesh, Mizoram, Sikkim, Nagaland and Orissa together contribute 70% to the country's total area and production. India is the largest producer of ginger in the world. In India, different types of Indian ginger are available like Cochin ginger (light brown or yellowish grey); Calicut ginger from Malabar (orange or reddish brown, resembling African ginger) and Kolkata ginger (greyish brown to greyish blue) (Khare, 2007).

Uses : 1) This is an important spice used in the preparation of condiments, curries, pickles and syrups.

2) Ginger has vasodilating property and widely used to increase circulation (Cammarata, 1996). It has also been used to relieve symptoms of colds and arthritis due to its anti-inflammatory properties (Kapil *et. al.*, 1990).

3) The decoction of ginger is beneficial in coryza (catarrhal inflammation of the mucous membrane in the nose, caused especially by a cold or by hay fever.), cough, headache and asthma (Hakeem, 2002).

4) In tradition medicine, ginger is extensively used for its specific action in rheumatism and inflammation of liver (Aiyer and Kolammal, 1964; Kurup *et. al.*, 1979). A study conducted in Shifa ul Mulk Memorial Hospital, Hamdard University, Karachi concluded that arthritin is effective for the treatment of rheumatoid arthritis (Owais, 2009).

5) In Ayurveda, ginger has been recommended for use as carminative, diaphoretic, antispasmodic, expectorant, peripheral circulatory stimulant, astringent, appetite stimulant, anti-inflammatory agent, diuretic and digestive aid (Johri and Zutshi, 1992).

5.14.3. ***Zingiber purpureum*** Rosc. in Trans. Linn. Soc. 8: 348. 1807; Baker in Hook. f. Fl. Brit. Ind. 6: 248. 1892; Balakrishnan, Fl. Jowai 2: 522.1983; A.S. Rao & D.M. Verma, Bull. Bot. Surv. India 14: 137. 1972; S. Kumar, Zingib. Sikkim 72. 2001; N.P. Singh *et. al*. in Fl. Mizoram 1:34-85. 2002; H. Lalram. Ethn. Med. Pl. Mizoram 301. 2003. **Photoplate XI (M)**

Scientific name : *Zingiber purpureum* Roscoe.

Local Name : Ramthing (Mizo), Pale (Chakma, Bru).

Common Name : Cassumar ginger (English), Banada (Hindi).

Locality : Lalmon-1 village, Southern Mizoram (cultivated in kitchen garden).

Altitude : 300 - 1000 m.

Habit : Rhizomatous herb.

Habitat : Tropical evergreen forests.

Botanical Description : A slender herb, arising from the root stock. *Rhizomes* aromatic, deep yellow inside. *Stem* leafy, 1-2 m high. *Leave* sessile, oblong-lanceolate, 3-6 x 25-35 cm, pubescent along midrib beneath. *Spikes* 2-4 x 7-15 cm, ellipsoid; *bracts* 2-3 x 3-5, broadly ovate, acuminate, greenish red turning to bright bred at maturity. *Flowers* yellow; *corolla lobes* 2-2.5 cm long, lanceolate; *lip* 2-3 x 1.8-2.5 cm, mid-lobe orbicular, lateral lobes ovate; *stamen* shorter than lip. *Fruit* globose.

Phenology : Flowering : August - September.
Fruiting : October - November.

Ecological status : Mostly cultivated in a small population, in wild, it is commonly found in moist, partially shaded evergreen and monsoon forests on soils rich in organic matter

Taxonomic status : Very rare.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : Cultivated along with *Ocimum tenuiflorum, Solanum melogana* etc. in kitchen garden.

Species examined : Mizoram, Lalmon, Lunglei Dist., *L. Vanchhawng & H. Lalramnghinglova* 42810 (MZU).

Distribution : Distributed in India, Cambodia, Laos, Vietnam, Sri Lanka and Malaysia. In India, this species is found in Western and Eastern Ghats, Madhya Pradesh, Karnataka, Kerala, Tamil Nadu; very rare in Mizoram, survived only in cultivation.

Uses : 1) *Chakmas* used the rhizome to cure cure stomach-ache and diarrhea and as stomachic (Lalram, 2003, Jain & Prakash, 1995 and Rahman & Yusuf, 1996).

2) In Thailand, rhizome is externally use as anti-inflammatory for sprain and muscular pain, wound healing. (Saralamp *et. al.*, 1996).

3) In Laos, this plant is used to treat poisoning, fever, diarrhea and abcesses. In Malaysia, it is used to mitigate stomachache, to treat rheumatism, to expel worms from intestine, and as a postpartum remedy. In Indonesia, the plant is used to cure fatigue, flatulence, diarrhea, constipation, cramps, obesity and jaundice (Christophe, 2012).

4) Extract from the rhizomes of *Z. purpureum* is reported to have anti-fungal activity against wide variety of human pathogenic fungi (Ficker *et. al.*, 2003).

5.14.4. ***Zingiber rubens*** Roxb. in Asiat. Res. 11: 348. 1810; Baker in Hook. f. Fl. Brit. Ind. 6: 243. 1892; A.S. Rao & D.M. Verma, Bull. Bot. Surv. India 14: 137. 1972; S. Kumar, Zingib. Sikkim 72. 2001. **Photoplate XI (H-J)**

Scientific name : *Zingiber rubens* Roxb.

Local Name : Not available.

Common Name : Bengal Ginger, Red Spotted Ginger (English).

Locality : Murlen N.P., Champhai District; Dampui Reserve Forest, mamit District.

Altitude : 400 - 1000 m.

Habit : Rhizomatous herb.

Habitat : Sub-tropical semi-evergreen forests.

Botanical Description : *Leafy stem* stout, upto 2.5 m high. *Leave* sessile 20-60 x 5-12, oblong-lanceolate, acuminate, puberulous beneath along midrib. *Spikes* 3-5 x 2-3 cm, sub-globose; *bracts* 3-5 cm long, ovate-oblong, red, bracteoles lanceolate, 4-5.5 cm long. *Flowers* red; *calyx* 3-4 cm long, pubescent, reddish; *corolla tube* 3-4.5 cm long, slightly inflated, lobes 2-3 cm long, lanceolate, the lateral two fused at the base, red; *lip* narrow, ovate, 2-3.5 x 0.7-1.5 cm, linear-oblong, deeply 3-lobed, yellowish white with red spots and streaks. *Anther* with small filament, beak of the anther bright red. *Capsule* ellipsoid, 4 x 1.5-2 cm, reddish.

Rhizomes remain underground through winter. Stems die down in autumn.

Phenology : Flowering : August - September.
Fruiting : September - October.

Ecological status : A small ginger undergrowth of semi evergreen forests in a rich loamy soil.

Taxonomical status : Very rare.

IUCN Category : The taxon has not been evaluated against the criteria as described in IUCN, 2014.

Associates : It is easily grown in cultivation, well adapted to most warm temperate climates and one of the few Zingiber sp. that tolerate cool winters while still a profusely flowering plant.

Species examined : Mizoram, Dampui, Mamit Dist., *L. Vanchhawng & H. Lalramnghinglova* 42819 (MZU).

Distribution : Originated in India. Bengal ginger is native to Eastern Himalayas and North East India.

Uses : 1) Seed capsules are used as spice.

2) A small pieces of rhizome of *Zingiber rubens* is boiled in water with a stem bark of *Ternstroemia gymnanthera* and the black pulp of *Cassia fistula*. This solution is administered to infants when cooled (Hynniewta & Kumar, 2009).

Remark : **First reported from Mizoram.**

Photo Plate – I

A - C : *Alpinia aquatica* (A-Flower, B-Fruit & C-Habitat).

D - E : *Alpinia bracteata* (D-Inflorecsence & E-Habitat).

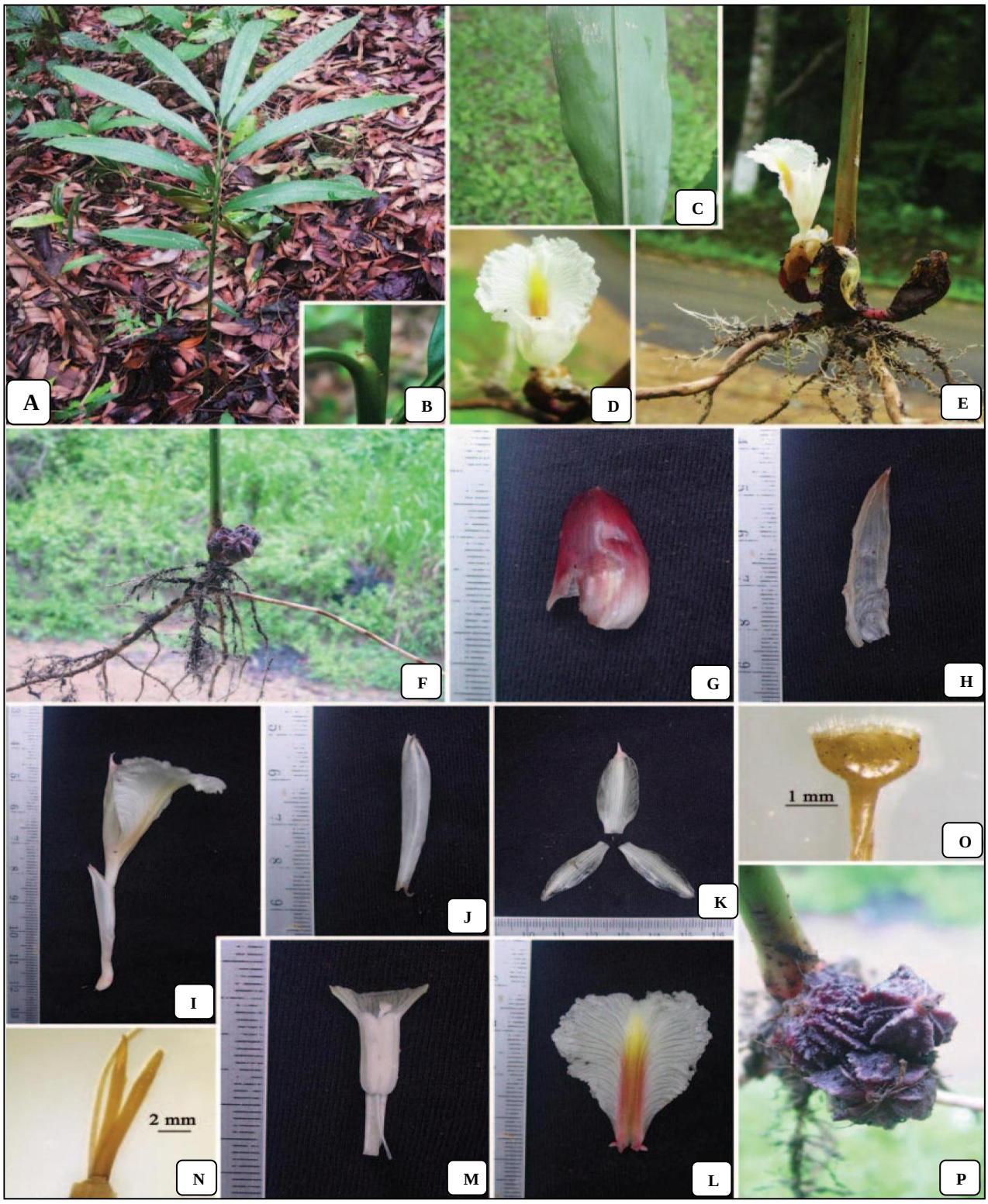
F - G : *Alpinia galangal* (F-Habitat & G-Inflorescence).

H - I : *Alpinia malaccensis* (H-Habitat & I-Flower).

Photo Plate – II

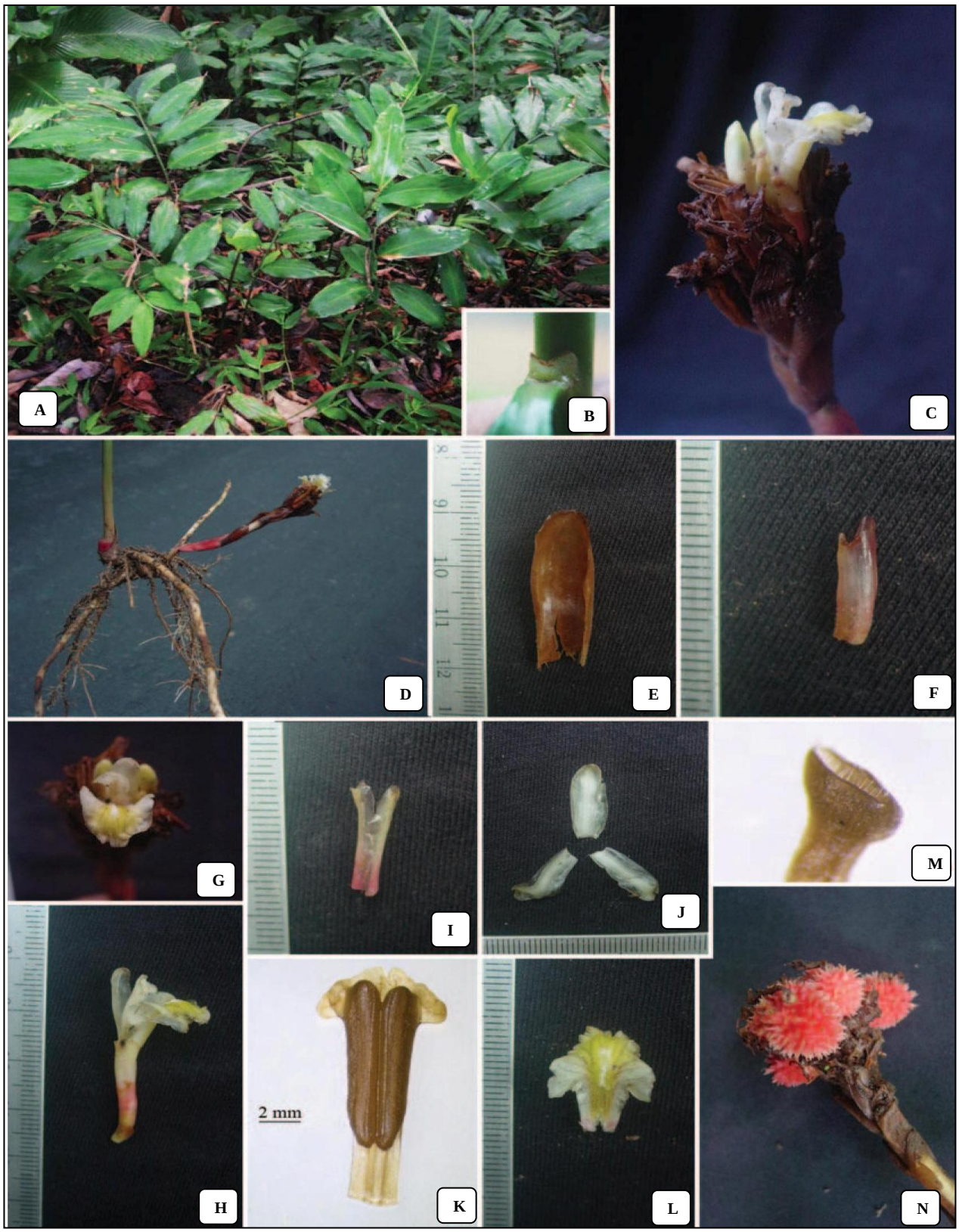
A	:	*Amomum corynostachyum* (Inflorescence).
B - D	:	*Amomum dealbatum* (B-Flower, C-Inflorescence & D-Habitat).
E - G	:	*Amomum aromaticum* (E-Inflorescence, F-Flower & G-Habitat).
H	:	*Amomum jainii* (Flower).
I	:	*Amomum aroamticum* (Flower).
J - K	:	*Amomum vermanum* (J-Fruit & K-leaves).
L - M	:	*Boesenbergis longiflora* (L-Flower & M-Habitat).
N - P	:	*Boesenbergia tiliaefolia* (N-Flower, O-Inflorescence & P-Habitat).

Photo Plate – III



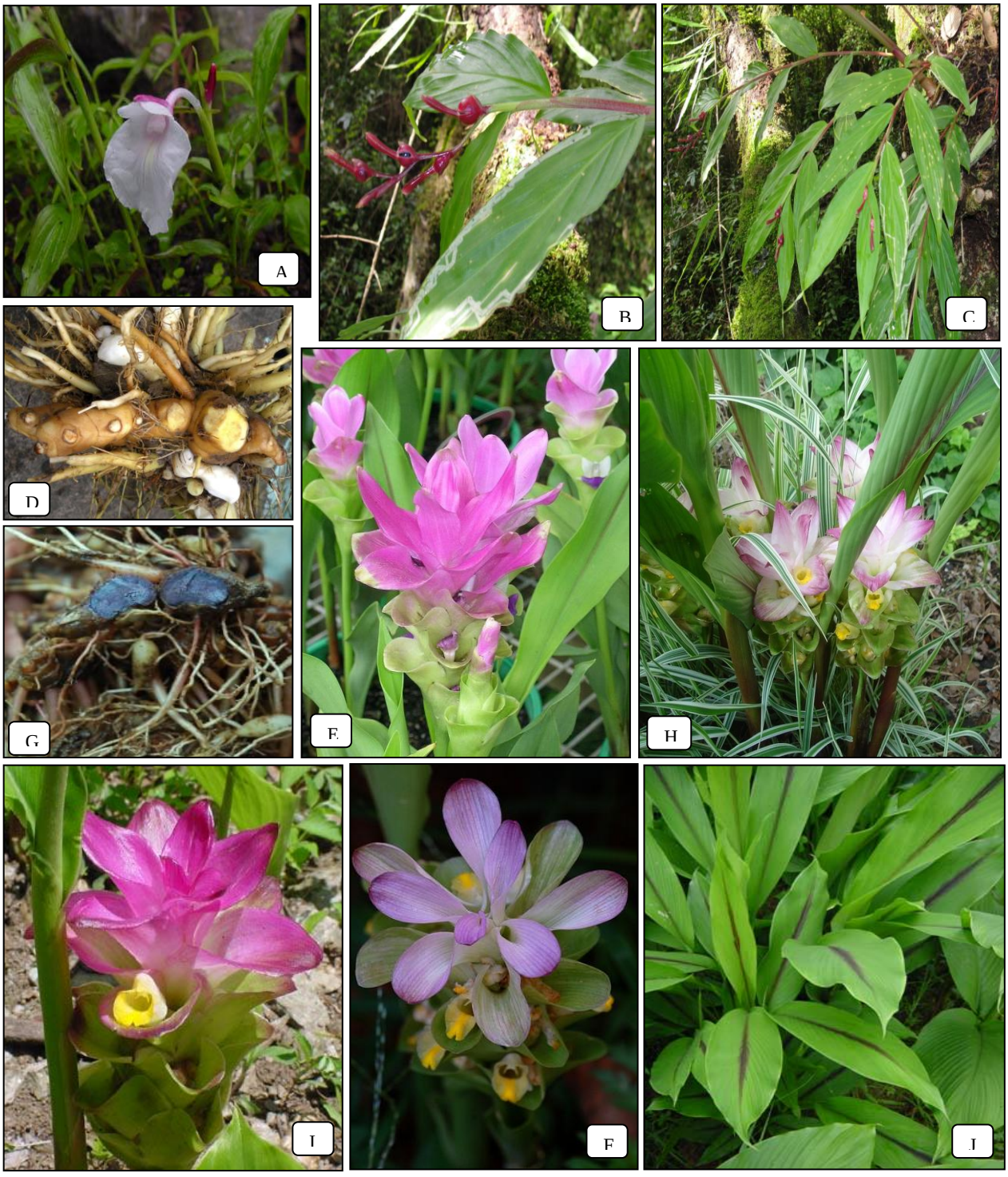
Amomum dampuianum : **A**-Habit, **B**-Ligule, **C**-Leave beneath, **D**-Flower, **E**-Inflorescence, **F**-Rhizome with infructescence, **G**-Bract, **H**-Bracteole, **I**-Calyx, **K**-Corolla lobes, **L**-Labellum, **M**-Stamen, **N**-Epigynous glands and Style, **O**-Stigma & **P**-Infructescence.

Photo Plate – IV



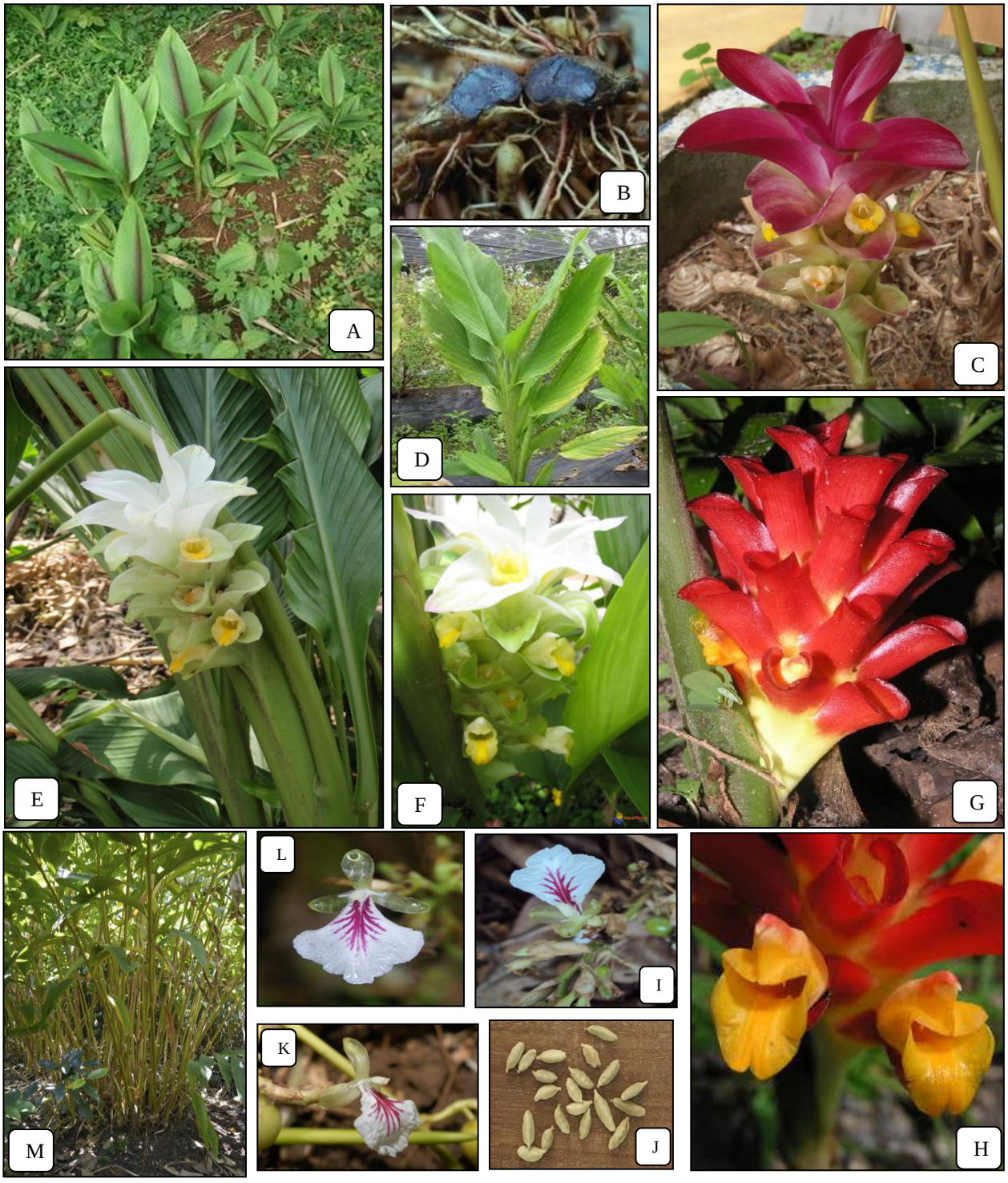
Amomum mizoramense : **A**-Habit, **B**-Ligule, **C**-Inflorescence, **D**-Rhizome with inflorescence, **E**-Bract, **F**-Bracteole, **G** & **H**-Flowers, **I**-Calyx, **J**-Corolla lobes, **K**-Stamen, **L**-Labellum, **M**-Stigma, **N**-Infructescence.

Photo Plate – V



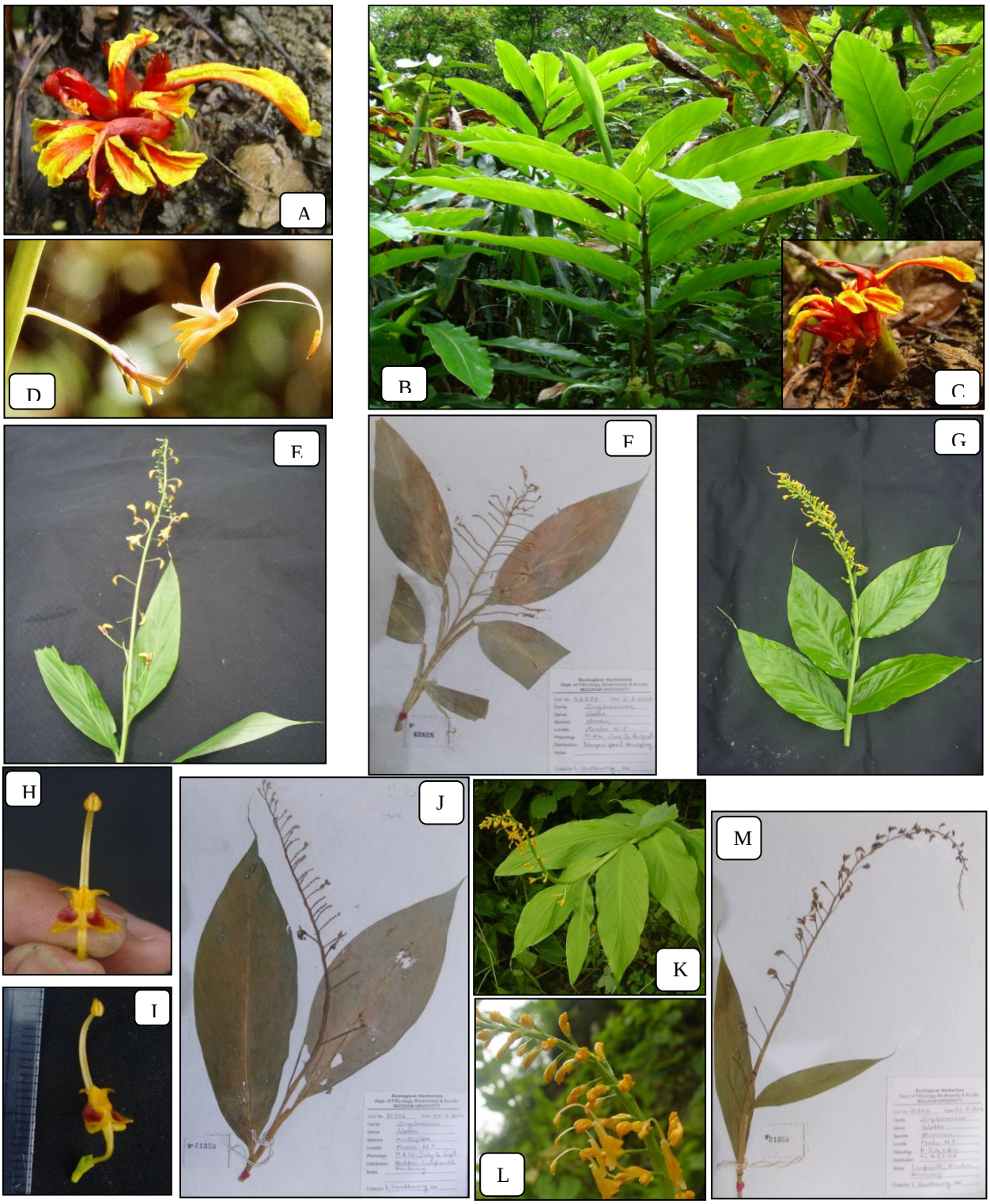
A	:	*Caulokaemferia linearis* (Flower).
B – C	:	*Cautleya gracilis* (B-Inflorescence & C-Habitat).
D - F	:	*Curcuma amada* (D-Rhizome, E-Habit & F-Inflorescence).
G - H	:	*Curcuma aeruginosa* (G-Rhizome & H-Inflorescence with habitat).
I - J	:	*Curcuma aromatic* (I-Inflorescence & J-Habit).

Photo Plate – VI



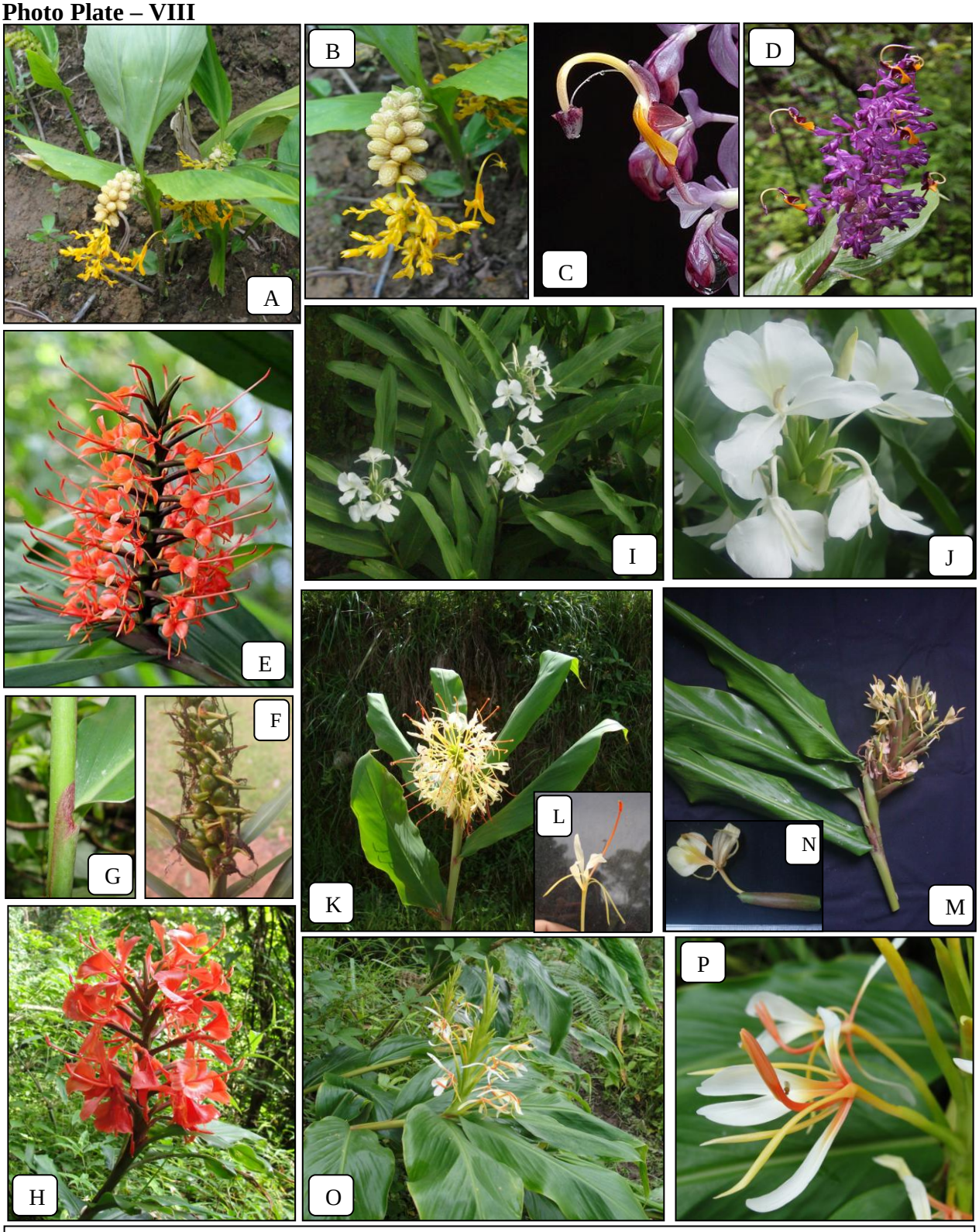
A - C :	*Curcuma caesia* (A-Habitat, B-Rhizome & C-Inflorescence).
D - F :	*Curcuma longa* (D-Habit, E-Inflorescence & F-Flower).
G - H :	*Curcuma rubrobracteata* (G-Inflorescence & H-Flower).
I - M :	*Elettaria cardamomum* (I-Flower with fruits, J-Seeds, K&L-Flowers and M-Habitat).

Photo Plate – VII



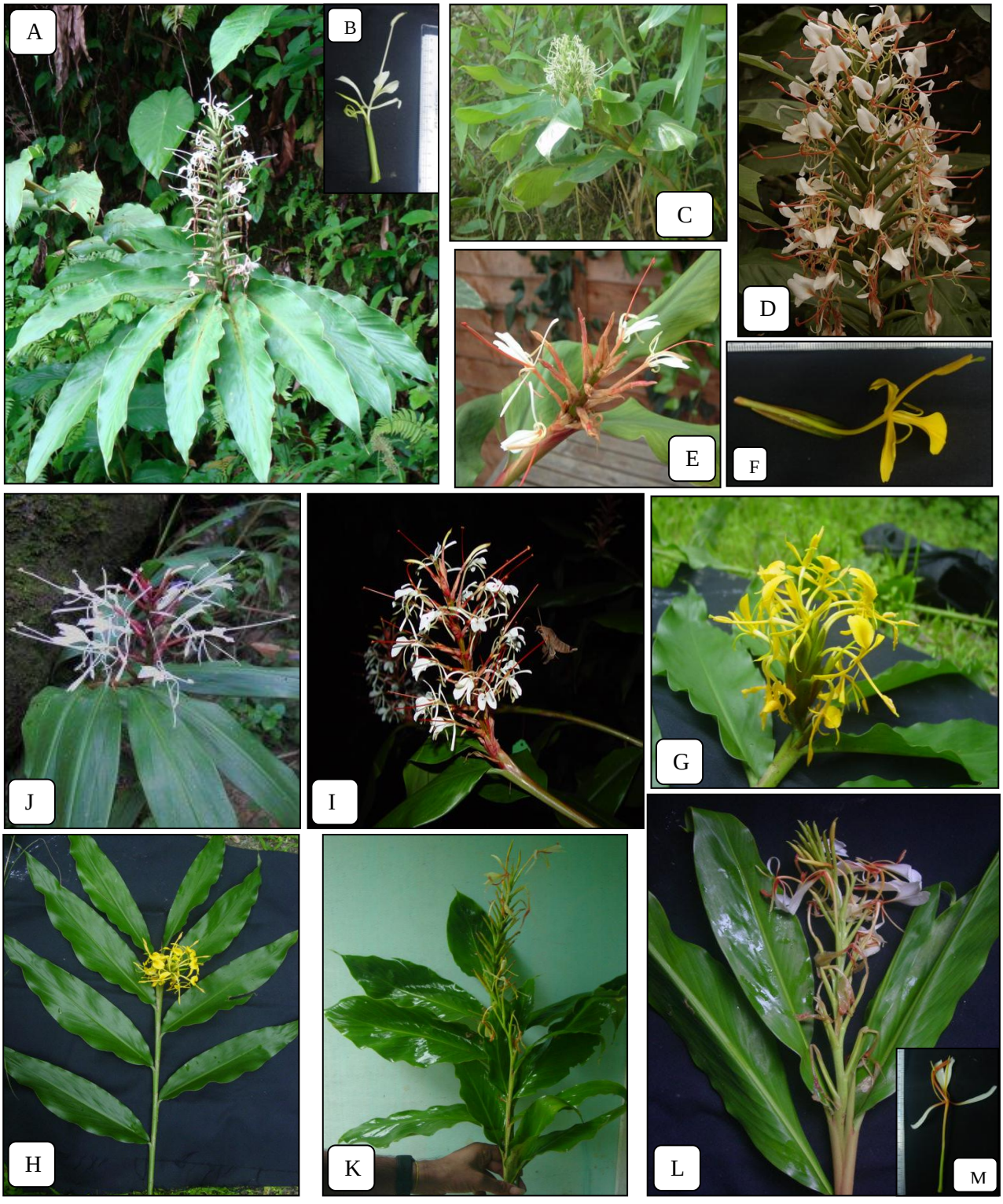
A - C :	*Etlingera linguiformis* (A&C-Inflorescence & B-Habit).
D - F :	*Globba clarkei* (D-Flower, E-Inflorescence & F-Herberium specimen).
G - J :	*Globba multiflora* (G- Inflorescence, H&I-Flowers & J-Herbarium specimen).
K - M:	*Globba orixensis* (K-Inflorescence, L-Flower & M-Herbarium specimen).

Photo Plate – VIII



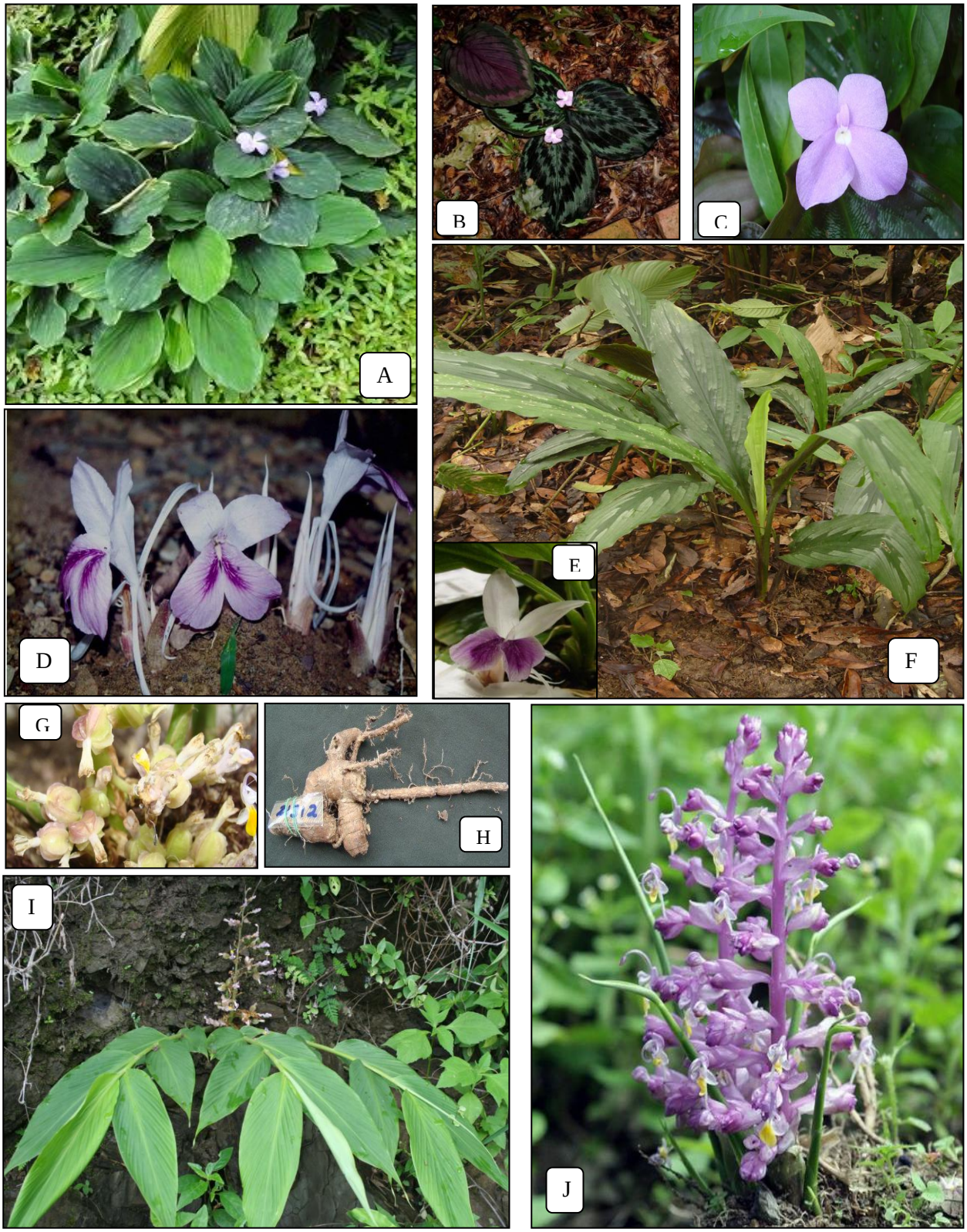
A - B : *Globba schomburgkii* (A-Habit & B-Inflorescence).
C - D : *Globba wardii* (C-Flower & D-Inflorescence).
E - F : *Hedychium coccineum* (E-Inflorescence & F-Fruit).
G - H : *Hedychium rubrum* (G-Ligule & H-Inflorescence).
I - J : *Hedychium coronarium* (I-Habit & J-Flowers).
K - L : *Hedychium ellipticum* (K-Habit & L-Flower).
M - N : *Hedychium flavescens* (M-Inflorescence and leaves & N-Flower).
O - P : *Hedychium spicatum* (O-Habit & P-Flowers).

Photo Plate – IX



A - B : *Hedychium stenopetalum* (A-Habit & B-Flower).
C : *Hedychium thyrsiforme* (Habit).
D - E : *Hedychium villosum* (Inflorescence).
F - H : *Hedychium wardii* (F-Flower, G-Inflorescence & H- Whole plant).
I - J : *Hedychium villosum var. tenuiflorum* (I-Inflorescence & J-Habit).
K - M: *Hedychium yunnanense* (K&L- Inflorescence & M-Flower).

Photo Plate – X

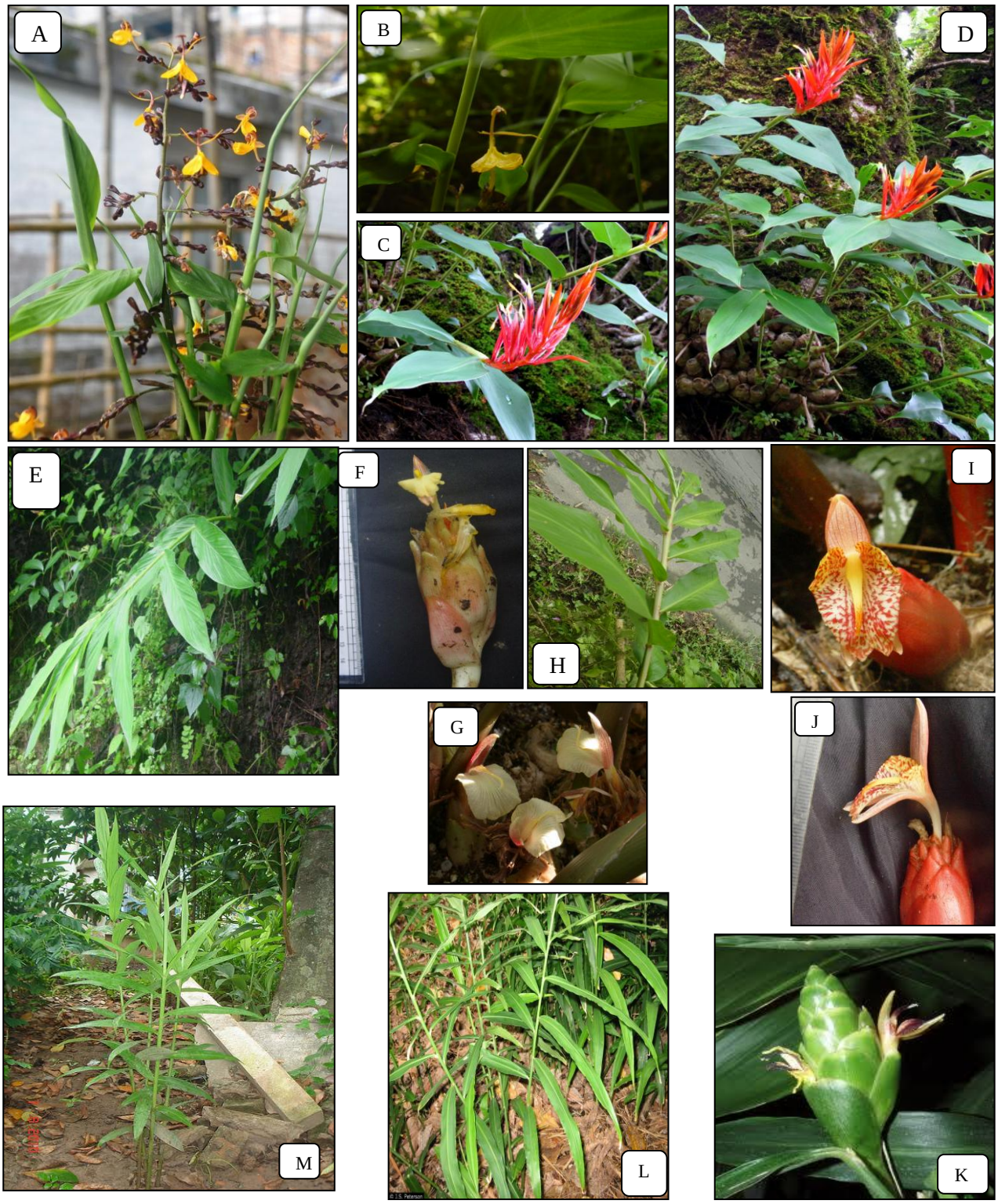


A - C : *Kaempferia pulchra* (A-Habitat, B-Habit & C-Flower).

D - F : *Kaempferia rotunda* (D-Inflorescence, E-Flower & F-Habitat).

G - J : *Mantisia spathulata* (G-Fruits, H-Rhizome, I-Habitat & J-Inflorescence).

Photo Plate – XI



A - B	:	*Mantisia wengeri* (A-Habitat & B-Flower).
C - D	:	*Rhynchanthus longiflorus* (C-Inflorescence & D-Habit).
E - G	:	*Zingiber ligulatum* (E-Habit, F- Inflorescence & G-Flowers).
H - J	:	*Zingiber rubens* (H-Habit and I & J-Inflorescence).
K - L	:	*Zingiber officinale* (K-Inflorescence & L-Habit).
M	:	*Zingiber purpureum* (Habit).

Chapter 6

DISCUSSION

Systematic study on taxonomy of Zingiberaceae was carried out in Mizoram during the year 2008-2014. During this period different species of Zingiberaceae were collected from 14 study sites in 8 districts *viz*., Aizawl, Champhai, Kolasib, Lawngtlai, Lunglei, Mamit, Saiha and Serchhip. This is the first significant contribution on systematic study on Zingiberaceae in Mizoram.

Zingiberaceae is mainly distributed in tropics and sub-tropical areas. Some few species are also found in temperate forests. They are mostly confined to the altitudinal range of 300-2000 m. Some species of Zingiberacea *viz. Amomum dealbatum, Alpinia bracteata, Alpinia aquatic, Etlingera linguiformis* are evergreen herbs inhabiting wet forests especially in light gaps and at forest margins. The family is mainly distributed in the fringe of the forests and along the road side in shady places. The species diversity is found to be lesser towards the forests. Many of the Zingiberaceae species were deciduous and remained dormant during dry season. Therefore collection of Zingiberaceae was carried out mainly during rainy season when the important characters like flowers, fruits and pseudostem appeared.

As mentioned earlier, the first detailed study on family Zingiberaceae was undertaken by Schumann (1904). Later, Holttum (1950) classified the family into three tribes *viz. Globbaeae*, *Hedychieae* and *Alpinieae* under the sub-family of Zingiberoideae. In his classification, 23 genera and 200 species were described and illustrated. Kress *et al.*, 2002 classification based on molecular phylogeny is the most recent and acceptable classification. In India, a total of 200 (approx.) species are known under 22 genera, out of which 14 genera are known from Mizoram representing 52 species with two varieties including 2 new species and 15 species which are reported for the first time from Mizoram.

During the course of the present study, three different life forms have been recognised, *viz.*, terrestrial, lithophytic or epiphytic and aquatic. *Rhynchanthus longiflorus,*

Mantisia wengerii, Hedychium villosum, Mantisia spathulata and, *Cautleya clarkei* are epiphytic or epyphitic in nature which grow mostly on rocks and tree trunks. *Alpinia aquatica* is the only Zingiberaceae species that has been found so far to be thriving in aquatic environment. The remaining 47 species of Zingiberaceae collected during the course of study are found in terrestrial habitat.

Among the 14 genera reported from Mizoram, the genus *Hedychium* Koenig. dominates all other genera thereby representing 13 species including two varieties. The genus *Amomum* represents 8 species with 2 new species *viz., A. dampuianum and A. mizoramense.* Seven (7) species of genus *Curcuma,* Six (6) species of *Globba,* four (4) species of *Amomum* have also been recorded. The genus *Zingiber* is represented by 4 species. Two species each of the genus *Boesenbergia, Kaempferia* and *Mantisia* are also recorded. The genus *Caulokaempferia, Cautleya, Elettaria, Etlingera* and *Rhynchanthus* are represented by 1 species each. Therefore, it can be observed that the genus *Hedychium* is represented by maximum number of Zingiberaceae species in Mizoram. The epiphytic species of Zingiberaceae *i.e. Rhynchanthus longiflorus,* collected by Lalramnhinglova in 2001 and rediscovered by Prashantkumar *et al.,* 2004 has also been collected from Phawngpui National Park. It is noteworthy to mention the rediscovery of *Alpinia aquatica,* which is the first record in India after Baker, 1892. This is the only aquatic species collected during the research period which nurtured in an aquatic environment.

The family Zingiberaceae is well known for its immense medicinal values and potentials. It is an important natural resource that provides many useful products for medicines, dyes, perfume and aesthetics. In this study, the information regarding the ethno-medicinal uses of Zingiberaceae by the local people of the study areas was systematically collected and critically analyzed. Out of the total of 53 Zingiberaceae members, 34 species

under 11 genera have been found to possess medicinal potentials which make 65% of the total number of Zingiberaceae collected during the research period. A close investigation revealed that about 18 species *viz., Alpinia galangal, Amomum aromaticum, Amomum dealbatum, Boesenbergia longiflora, Boesenbergia tiliaefolia, Curcuma amada, Curcuma aromatic, Curcuma caesia, Curcuma longa, Curcuma zedoaria, Elettaria cardamomum, Globba multiflora, Hedychium coronarium, Hedychium spicatum, Hedychium villosum, Kaempferia rotunda, Zingiber officinale and Zingiber purpereum* are known for their use to cure multiple disorders and are primarily effective against wide range of diseases. The traditional knowledge and available scientific literature revealed that the primary medicinal activity seems to be against hypertension, gastro-intestinal ailments, stomatitis, dyspepsia, dysentery, respiratory diseases, rheumatism, scabies and skin problems. The plants are also used as antiseptic, anti-inflammation, carminative and anti-spasmodic. *Curcuma aromatic* and *Hedychium spicatum* are reported to have been used for the treatment of cancer by the local medicine men.

In respect of species diversity in different study sites, Murlen National Park has the highest number of Zingiberaceae species with a total number of 24 species. Important species collected are *Hedychium spicatum, Hedychium flavescens Hedychium thyrsiforme, Hedychium rubrum, Hedychium coronarium, Hedychium spicatum, Hedychiuam yunnanense, Hedychium stenopetalum, Hedychium wardii, Hedychium villosum, Hedychium ellipticum, Zingiber rubens, Zingiber purpureum, Curcuma amada, Globba racemose, Globba wardii, Globba orixensis, Globba multiflora* etc. The genus *Hedychium* has the maximum number of species found in Murlen National Park with a record of 11 species in this particular area. The higher in species diversity of this area may be due lesser disturbance by various anthropogenic activities like *jhuming* cultivation, collection of fire-woods and timber etc. Further, Murlen National Park has been classified under sub-tropical evergreen forest which

is the ideal place for the growth of Zingiberaceae. Likewise, the genus *Amomum* and *Alpinia* have been collected abundantly from the western part of Mizoram, *viz.,* Dampa Tiger Reserve, Dampui Reserve Forest and Ngengpui Wildlife Sanctuary. These areas are falling under Tropical evergreen and semi evergreen forests.

Important species of Zingiberaceae which have high ethno-medicinal value like *Alpinia galangal, Amomum aromaticum, Curcuma amada, Curcuma aromatic, Curcuma caesia, Curcuma zedoaria, Globba schromburkii, Globba multiflora, Hedychium spicatum, etc.* are collected and cultivated in the Botanical Garden of Mizoram University Campus. Rare, Threatened and Endangered species like *Rhynchanthus longiflorus, Mantisia spathulata, Mantisia wengerii, Alpinia aquatic* are also collected and cultivated. In order to study systematic classification and identification of Zingiberaceae family, Herbarium specimen of all the collected species have been prepared, preserved and deposited in the Herbarium of Mizoram University, Aizawl.

The two species of the genus *Mantisia viz., M. spathulata and M. wengeri* are endemic to Mizoram. These two species are very vital plants which are on the verge of extinction due to excessive deforestation, fragmentation, burning of forest and shifting cultivation practices. They are found in a small population only in two restricted areas of Mizoram, *viz.,* Reiek forest, Mamit District and Sethlun, Lunglei District. *M. spathulata* has been listed in the Red Data sheet of India plants as being rare and endangered species by Botanical Survey of India and is found only in rocky hills of Sethlun, Lunglei district. The rarity of *M. wengeri* also has reached a critical level with only 60-70 plants and therefore been included in the national priority list for its recovery by the department of Biotechnology, New Delhi. It is important to note that the four species of *Mantisia* are formally transferred into *Globba* but retained as a distinct section (Kress *et. al.,* 2002). By submerging *Mantisia*

into *Globba*, two characters become synapomorphies for the genus within the Zingiberaceae. But in this research, the genus *Mantisia* and *Globba* are classified as different genera as all the available literature and earlier research classified the two as different genera.

The discovery of two new species of *Amomum viz., Amomum dampuianum* and *Amomum mizoramense* has contributed a significant progress for plant taxonomy in Mizoram. Field investigation was conducted in collaboration with Prof. M. Sabu and Research students, Calicut University, Kerela under the DST Project during 2009-2010. Under critical examination through modern taxonomical devices and Index Kiwensis and supplements, the two specimens are found to be species nova and named them *Amomum dampuianum* M. Sabu, V.P. Thomas & H. Lalramnghinglova after the place of collection, that is, Dampui village near Mamit town, and; *Amomum mizoramense* M. Sabu, V.P. Thomas & L. Vanchhawng in the state of Mizoram, respectively. These two species are found growing as undergrowth in the evergreen forest of Dampui Reserve Forest in Mamit District of Mizoram and added to the Indian flora.

Research on Zingiberaceae offers promising development of natural resources into nutraceuticals, cosmeceuticals and biopharmaceuticals. Essential oils of Zingiberaceae are highlighted by aromatherapists and cosmetic manufacturers as new oriental fragrances. The essential oil is also reported as an organic insect repellent. Analysis of the chemical constituents of the Zingiberaceae leaves can be conducted in anticipation of a taxonomic application of the outcomes of our study. Antimicrobial activity has been demonstrated from *Zingiber montanum*. A number of species such as *Alpinia purpurata, A. zerumbet, Etlingera elatior* and *Zingiber zerumbet* were found to inhibit the growth of *Mycobacterium tuberculosis.* Roots of *Hedychium* and *Curcuma* show presence of arbuscular mycorrhizal

fungal colonization. There should be a preliminary assessment of the extent of mycorrhizae and their variations in this family for future horticultural purposes.

As many as 250 species of this family are cultivated as ornamentals throughout the world. Some varieties have fragrant flowers and others have scented and beautifully variegated foliage; they can be domesticated for ornamental purposes. Data on specific floral features and flowering characteristics will be noted in order to determine the most promising cut flower types as well as the potted-colour characteristics identified by the commercial nurseries.

Sixty three species of Zingiberaceae are used by local communities in Indo-China as medicines, vegetables, for religious purposes, as food flavourings and spices, in handicrafts, and as ornamentals. The uses of many gingers species in traditional religious activities, such as rice cultivation, ceremonies and offerings, protection, attraction and taboos are also notable.

Although a number of systematic study have been conducted during the study period, there are still many species that remain undescribed and yet to be documented particularly in Murlen National Park and Dampa Tiger Reserve, either due to insufficient materials for identification such as flowers or some of their characteristics did not fit to any of the described species. These specimens are believed to be new to science.

The resurgence of interest in herbs and the potential lucrative revenues anticipated from the herbal industry have spurred renewed interest in exploiting traditional knowledge and practices into scientific realities: use of local essential oil in product development, especially towards the pharmaceutical, fragrance and cosmetic industries.

Chapter 7

SUMMARY

&

CONCLUSIONS

7.1 The study was carried out during 2008-2014. Frequent and regular visits have been carried out in study area with a view to understand floristic composition, ecology, distribution, ethnobotanical uses of the species. Collection, processing and identification of the plant materials were done following standard taxonomic methods.

7.2 The state Mizoram is situated in the southernmost part of the Northeast India which is one of the biodiversity hot spots of the globe.

7.3 The family Zingberaceae is a large flowering plant family that comprises *ca.* 53 genera and *ca*. 1200 species distributed in pantropical and sub-tropical of Africa, Asia, and the Americas, with their greatest diversity in Southeast Asia; few species are also reported from temperate regions.

7.4 An important distinguishing characteristic is the presence of essential oils in their tissues and the presence of a lip or labellum that is usually formed by the fusion of the two sterile stamens. They are small to large perennial plants with creeping horizontal or tuberous rhizomes. Plants are self supporting or epiphytic. The alternate evergreen leaves often have sheaths that form a pseudostem.

7.5 An updated exhaustive review of literature on the taxonomy of World Zingiberaceae has been presented as a step towards understanding and identifies the hiatus existing in the knowledge of Indian Zingiberaceae.

7.6 Out of *ca.*200 species known from India, 53 species under 14 genera of Zingiberaceae were collected from Mizoram; 2 species were described as new to science. This is the first significant contribution to the study of Zingiberaceae from Mizoram.

7.7 Descriptions of 15 species have been reported for the first time from Mizoram, which have added to the information available on the Zingiberaceae of India.

7.8 Systematic taxonomic keys for the identification of the family Zingiberaceae are given.

7.9 A relevant lists of references pertaining to the study have been presented

7.10 India being a vast country with a diverse agro climatic zones and rich biodiversity, it is quite likely that many more species of Zingiberaceae may still remain unidentified especially in North Eastern region which provide a huge scope for further investigation.

7.11 The present study highlights the need for intensive study of Zingiberaceae in the remaining parts of India, particularly in the North eastern region as related to the ecological and geographical distribution pattern of various genera. Since most of Zingiberaceae species has a high medicinal potential, it is suggested to undertake further intensive research on bioactive principles through biotechnological tools. The pharmacological study to identify the usefulness of the plant against a particular ailments and phytochemical study for identifying the exact molecules from such inventory is recommended.

7.12 Since the study area is rich in species of Zingiberaceae with majority of them possessing medicinal values, the further ethnobotanical study need be carried out. The traditional knowledge of ethno-medicine has been passing on mouth by mouth since the pre-historic era and the information collected is totally verbal without any written documents. Therefore, there is an utmost need to document the traditional and cultural practices of the ethnomedicinal plants from the different community of the study area.

The present study is first of its kind with morphological structures, photographs, illustrations and distribution of each and every species of Zingiberaceae from the state of Mizoram. This taxonomic works results in a better understanding of nomenclatural updates, delimiting of species, new additions to the existing flora, rediscovery of rare species, discovery of the ethno-botanical uses of Zingiberaceae from the state of Mizoram. Moreover, this research work will give a complete account of the species under this family, morphological accounts, distribution status & conservation priorities for in situ conservation, relationship among taxa and ethno-botanical uses of the species found in Mizoram.

REFERENCE

Agrawal, S., Bhawsar, A., Choudhary, P., Singh S., Keskar, N. and Chaturvedi, M. (2011). In-Vitro anthelmintic activity of Kaempferia rotund. *International Journal of Pharmacy & Life Sciences* **2(9)**: Sep., 2011.

Aiyer, K. N. and Kolammal, M. (1964). *Pharmacognosy of Auyrvedic drugs*. Department of Pharmacognosy, Univ of Kerala Trivandrum. **9**:122.

Asolkar, L.V., Kakkar, K.K. and Chakre, O.J. (1992). *Glossary of Indian medicinal plants with active principles, Part I.* Publications and Information, CSIR, New Delhi, India, pp 232-233.

Amiril, N.A. (2006). *Optimization of essential oil extraction from Zingiber officinale*. A thesis submitted in Faculty of Chemical and Natural Resources Engineering University College of Engineering & Technology Malaysia.

Anonymous (1991). Census of 1991. List of Scheduled Caste and Scheduled Tribe, p1.

Anonymous (1994). *The Tribes of Mizoram.* Tribal Research Institute, Directorate of Art & Culture, Aizawl, Mizoram, pp.1-116.

Anonymous (1999). *Soils of Mizoram.* Directorate of Agriculture, Aizawl, Mizoram, India, pp.1-7.

Anonymous (2001). *Statistical Handbook of Mizoram.* Directorate of Economics and Statistics, Government of Mizoram, pp.1, 122-123.

Anonymous (2008). *Statistical Hand Book of Mizoram 2008.* Directorate of Economics & Statistics, Aizawl, Mizoram.

Anonymous (2011). *India State of Forest Report 2011: Mizoram*. Forest Survey of India, pp. 186-190.

Anonymous (2013). *Statistical Abstract of Mizoram: 2013*. Directorate of Economics & Statistics, Aizawl, Mizoram, pp. 1-236.

Arulmozhi, D.K., Sridhar, N., Veeranjaneyulu, A. and Arora, K.S. (2006). Preliminary mechanistic studies on the smooth muscle relaxant effect of hydroacloholic extract of *Curcuma caesia. J. Herb. Pharmacotherapy* **6**:3-4.

Baby, S., Varughese, G., Mathew, D. and Nediyaparambu, S.P. (2007). Chemical composition and antimicrobial activities of the essential oils from the rhizomes of four *Hedychium* species from South India. *J. Essen. Oil Res.* **19**(1):93-97.

Bailey, L.H. (1949). *Manual of cultivated plants* (6^{th} ed. 1961). New York.

Baker, J.G. (1890). Scitamineae. *In:* Hooker, J.D. (Ed.) *The Flora of British India, Vol. 6,* pp.198-264. L. Reeve & Co. Ltd., London, UK.

Balakrishnan, N.P. (1983). *Flora of Jowai, Vol. 2 - A contribution towards a detailed knowledge of the flora of the Northeastern region of India.* Botanical Survey of India, pp.518-530.

Bentham, G. and Hooker, J.D. (1883). *Genera Plantarum Vol. 3*. L**.** Reeve & Co, London.

Bisht, G.S., Awasthi, A.K. and. Dhole, T.N. (2006). Antimicrobial activity of *Hedychium spicatum. Fitoterapia* **77**:240–242.

Borah, R.L. and Sharma, G.C. (2012). Systematic survey of Zingiberaceae of Dibrugarh District, Assam. *Ind. J. Fund. App. Life Sc.* **2**(2):365-37.

Burkill, I.H. (1966). *A Dictionary of the Economic Products of the Malay Peninsula, Vol. 1.* Ministry of Agriculture and Co-operatives, Kuala Lumpur.

Burtt, B. L. and Smith, R. M. (1972). Tentative keys to the subfamilies, tribes and genera of the Zingiberales. *Notes from the Royal Botanic Garden Edinburgh* **31**: 171–176.

Burtt, B.L., and Smith, R.M. (1983). *A revised handbook to the Flora of Ceylon – Zingiberaceae, Vol. 4*. Oxford & IBH Publishing Co., New Delhi, pp.488-532.

Burtt, B.L. and Smith, R.M. (1983). Zingiberaceae. *In:* Dassanayake, M.D. (ed.) *A revised Handbook to the Flora of Ceylon, Vol. 4,* pp.499-505. Amerind Publishing Company Pvt. Ltd., New Delhi.

Burtt, B.L. (1972). General introduction to papers on Zingiberaceae. *Notes Royal Botanical Garden Edinburgh* **31**:155-165.

Cammarata, J. (1996). *A Guide to herbal remedies.* Goodwill Publishing House, New Delhi, pp.71-140.

Census, (2011). *Mizoram Population Census data 2011.* http://www.census2011.co.in/census/state/Mizoram.html. Downloaded on 03.10.2014.

Changli, Z. (1992). A study of the ethnic origin and custom of the nationalities in the North-Eastern area in India. *In:* Hluna, J.V., Sangkima, and Buragohain, R. (eds.). *Minority nationalities of Northeast India - The Mizos.* Seminar Committee, Directorate of Higher & Technical Education, Government of Mizoram, pp.1-20.

Chatterjee, N. (1978). *Puan - The pride of Mizoram*. Firma KIM Private Limited on behalf of Tribal Research Institute, Aizawl, Mizoram, pp. 67-74.

Chatterjee, S. (1990). *Mizoram Encyclopedia.* Jaico Publishing House, Bombay **3:**516-667.

Chawngkunga, C. (1996). *Tualchhuak Damdawi (Indian System of Medicines).* Directorate of Health & F.W. Govt. of Mizoram, Aizawl, 309p.

Chitra, M. and Thoppil, J.E. (2008). A pharmacognostical report on the rhizome of *Alpinia galanga* Linn. (Willd). *Ancient Science of Life* **27**(4): 9-21.

Chopra, R.N., Nayar, S.L. and Chopra, I.C. (1980). *Glossary of Indian Medicinal Plants*. Council of Scientific & Industrial Research, New Delhi, pp.191-258.

Chowdheri, H.J., Giri, G.S. and Pramanik, A. (2009). *Materials for the Flora of Arunachal Pradesh (Hydrocharitaceae – Poaceae) Vol-3*. Botanical Survey of India, MoEF, pp.169-183.

Christophe, W. (2012). *Medicinal Plants of China, Korea and Japan: Bio-resource for Tomorrow's Drugs and Cosmetics.* CRC Press, Taylor & Francis Group, 432p.

Daduang, S., Sattayasai, N., Sattayasai, J., Tophrom, P., Thammathaworn, A., Chaveerach, A. and Konkchaiyaphum, M. (2005). Screening of plants containing *Naja naja siamensis* cobra venom inhibitory activity using modified ELISA technique. *Analytical Biochemistry* **341**(2):316-325.

Dahlgren, R.M.T., Clifford, H.T, and Yeo, P.F. (1985). *The Families of Monocotyledons.* Springer-Verlag, New York.

Deb, B.J and Dutta, R.B. (2004). *Changing agricultural scenario in North East India.* Ashok Concept Publishing Company, New Delhi.

Deb, D.B. (1983). *The Flora of Tripura State - Zingiberaceae Vol-2.* Today & Tomorrow's Printers and Publishers, pp.366-380.

Dhetchuvi, M.M. (1993). Observations sur les Zingiberaceae de l'Afrique Centrale 1. *Aframomum singulariflorum* Dhetchuvi, nouvelle espèce du Zaïre souvent confondue avec *A. melegueta* (Roscoe) K. Schum. *Bulletin du Jardin Botanique National de Belgique* **62:**181-186.

Dhetchuvi, M.M. (1995). Observations on the Zingiberaceae of Central Africa: 2. *Aframomum makandensis* Dhetchuvi, a new species from the Foret des Abeilles Gabon. *Bulletin du Jardin Botanique National de Belgique* **64**(1-2): 197-200

Dhetchuvi, J.B. and Fischer, E. (2006). A new species of *Aframomum* (Zingiberaceae) from Nyungwe National Park/Rwanda. *Systematics and Geography of Plants* **76**: 241-254.

Don, D. (1825). Gastrochilus. *In: Prodromus Florae Nepalensis*. Gale, London, pp.32.

Duke, J.A., Bogenschutz, Godwin, M.J., DuCelliar, J. and Duke, P.K. (2002). *Hand book of medicinal herbs* (2nd ed). Boca Raton, CRC Press, pp 153-154.

Dutta, A. (1992). *Ethnicity and Statehood in Mizoram. In:* Hluna, J.V., Sangkima, and Buragohain, R. (Eds) *Minority nationalities of Northeast India-The Mizos, p.45.* Seminar Committee, Directorate of Higher & Technical Education, Government of Mizoram.

. Ficker, C.E., Smit, M.L., Susiarti, S., Leaman, D.J., Irawati C. and Arnason, J.T. (2003). Inhibition of human pathogenic fungi by members of Zingiberaceae used by the Kenyah (Indonesian Borneo). *J. Ethnopharmacol* **85**: 289-293.

Fischer, C.E.C. (1928). *Flora of the Presidency of Madras*. Adlard & Son Co. Ltd., London, 1390p.

Fluckiger, F.A. and Hanbury, D. (1879). *Pharmacographia: A History of the Principal Drugs of Vegetable Origin Met Within Great Britain and British India*. Macmillan & Co., London.

Ganeshaiah, K.N. (2005). Recovery of endangered and threatened species: Developing a national priority list of plants and insects. *Current Science* **89:** 599-600.

Gao, J.Y., Zhang, L., Deng, X.B., Ren, P.Y., Kong, J.J. and Li, Q.J. (2004). The floral biology of *Curcumorpha longiflora* (Zingiberaceae): A ginger with two-day flowers. *Amer. J. Bot.* **91**: 289-293.

Germer, S. and Franz, G. (1997). Ginger: A multi-purpose drug. *Deutsche Apotheker Zeitung* **137**(47): 4260-4266.

Gopanraj, G., Dan, M., Shiburaj, S., Sethuraman, M.G. and George, V. (2005). Chemical composition and antibacterial activity of the rhizome oil of *Hedychium larsenii*. *Acta Pharmaceutica* **55**(3): 315–320.

Govaerts, R. (2004). *World Checklist of Monocotyledons Database in ACCESS*: 1-54382. The Board of Trustees of the Royal Botanic Gardens, Kew.

Grieson, G.A. (1908). *Linguistic Survey of India Vol (iii) Part (iii).* Motilal Banarsidas, Delhi (Reprint 1967), pp.75-143.

Haines, H.H. (1925). *The Botany of Bihar and Orissa Vol-III.* Botanical Survey of India, Calcutta, pp.1178-1198.

Hakeem, A.M. (2002). *Bustanul Mufradat.* Idarae Taraqqie Urdu Publications, New Delhi, India.

Hanh, N.P., Binh, N.Q. and Adhikari, B.S. (2014). Distribution of *Alpinia* (Zingiberaceae) and their use pattern in Vietnam. *J. Biodiversity and Endangeed Species* **2**: 121.

Harlan, J.R. (1975). *Crops and Man.* American Society of Agronomy, Madison, Wisconsin. 295pp.

Harris, D.J., Poulsen, A.D., Frimont-Moller, C., Preston, J. and Cronk, Q.C.B. (2000). Rapid radiation in *Aframomum* (Zingiberaceae): Evidence from nuclear ribosomal DNA internal transcribed spacer (ITS) sequences. *Edin. J. Bot.* **57**: 377–395.

Hasan, H.A., Raauf, A.M.R., Razik, B.M.A. and Hassan, B.A.R. (2012). Chemical composition and antimicrobial activity of the crude extracts isolated from *Zingiber officinale* by different solvents. *Pharmaceutica Analytica Acta* **3**:9.

Hengmanga, Z. (1992). *LAIMI.* Art & Culture Department, Lai Autonomous District Council, Lawngtlai, pp.1-69.

Henry, A.N., Chitra, V. and Balakrishnan, N.P. (1989). *Flora of Tamil Nadu Vol-3, Series I: Analysis.* Botanical Survey of India, Southern Circle, Coimbatore.

Holttum, R.E. (1950). The Zingiberaceae of Malay Peninsula. *Gard. Bull. Singapore* **3**:1-249.

Hooker, J. D. (1872-1897). *The Flora of British India, Vol 7*. London.

Hrahsel, Z. (1988). *Variability in soil properties under shifting cultivation in Mizoram.* M.Sc. Thesis in Agriculture Chemistry and Soil Science, Assam Agriculture University, Jorhat, Assam, pp.1-210.

Husain, A., Virmani, O.P., Popli, S.P., Misra, L.N., Gupta, M.M., Srivastava, G.N. and Singh A.K. (1992). *Dictionary of Indian Medicinal Plants*. CIMAP, Lucknow, India, 546 pp.

Hynniewta, S.R. and Kumar, S. (2009). The lesser-known medicine Ka Dawai Niangsohpet of the Khasis in Meghalaya, Northeast India. *Ind. Jour. Trad. Know.* **9**(3): 475-479.

Ibrahim, H. (1992). *Collection, documentation and conservation of Zingiberceae germplasm.* World Wildlife Fund, Malaysia, pp.1-34.

Israr, F., Hassan, F., Naqvi, B.S., Azhar, I., Jabeen, S. and Hassan, S.M.F. (2012). Studies on antibacterial activity of some traditional medicinal plants used in folk medicine. *Pak. Jour. Pharm. Sci*. **25**(3): 669-674.

I.U.C.N. (2001) *The IUCN Red List Categories and Criteria. Version 3.1*. http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria. Downloaded on 25 January 2015.

I.U.C.N. (2010). *Guidelines for Using the IUCN Red List Categories and Criteria* http://www.iucn.org/about/work/programmes/species/who_we_are/about_the_species_survival_commission_/ssc_leadership/ssc_sub_committees/standards_and_petitions_sub_committee/ Downloaded on 21 December 2014.

I.U.C.N. (2014) *The IUCN Red List of Threatened Species. Version 2014.3*. http://www.iucnredlist.org. Downloaded on 17 November 2014.

Jager, P. (2003). *Turmeric: The ayurvedic spice of life*. Om Organics, Veda.

Jain, S.K. and Prakash, V. (1995). Zingiberaceae in India: Phytogeography and Endemism. *Rheedea* **5**(2): 154-169.

Jain, S.K. and Rao, R.R. (1977). *Handbook of field and herbarium methods*. Today and tomorrow's Printers and Publishers, New Delhi, 157p.

Jain, J.P., Naqvi, S.M.A. and Sharma, K.D. (1990). A clinical trial of volatile oil of *Curcuma longa* Linn. (Haridra) in cases of bronchial asthma (Tamaka Swasa). *J. Research in Ayurveda and Siddha* **11**(1-4):20-30.

Jasril, L.Y., Mooi, A.M., Ali, M.A., Sukari, A.A., Rahman, A.G., Othman, H., Kikuzaki and Nakatani, N. (2003). Antioxidant and antitumor promoting activities of the flavonoids from *Hedychium thyrsiforme*. *Pharmaceutical Biology* **41(**7): 506-511.

Johri, R.K. and Zutshi, U. (1992). An ayurvedic formulation 'Trikatu' and its constituents. *J. Ethnopharmacology*. **37**: 85-91.

Kagyung, R., Gajurel, P.R., Rethy, P. and Sing, B. (2010). Ethnomedicinal plant used for gastro-intestinal diseases by Adi tribe of Dehang-Debang biosphere reserve in Arunachal Pradesh. *Ind. J. Traditional Knowledge* **9**(3):496-501.

Kala, C.P. (2005). Ethnomedicinal botany of the Apatani in the Eastern Himalayan region of India. *J. Ethnobiology and Ethnomedicine* **1**:11.

Kapil, U., Sood, A.K. and Gaur, D.R. (1990). Maternal beliefs regarding diet during common childhood illnesses. *Ind. Pediatrics* **27**(6): 595-599.

Kapoor, L.D. (1990). *Handbook of Ayurvedic medicinal plants.* CRC Press, Boca Raton, 172p.

Karthikeyan, S. (1996). *An Enumeration of the Zingiberaceae of India. In:* Wu, T.L., Wu, Q.G., Chen, Z.Y. (Eds) *Proceedings of the 2nd Symposium on the Family Zingiberaceae.* Zhongshan University Press, Guangzhou.

Karthikeyan, S., Jain, S.K., Nayar, M.P. and Sanjappa, M. (1989). *Florae Indicae Enumeratio Monocotyledonae.* Botanical Survey of India, Calcutta, pp.289-299.

Kemp, R. (2003). Effect of cardiac resynchronization on myocardial efficiency and regional oxidative metabolism. *J. Econ. Taxon. Bot.* **27**: 485.

Khare, C.P. (2000). *Indian Herbal therapies- Application of research findings.* Vishv vijay Private Ltd., New Delhi, India.

Khare, C.P. (2007). *Indian Medicinal Plants: An Illustrated Dictionary*. Springer Publications, New York, USA.

Kiew, K.Y. (1982). The genus *Elettariopsis* (Zingiberaceae) in Malaya. *Note. Roy. Bot. Gard. Edin*. **42**: 295-314.

Kittipanangkul, N. and Ngamriabsakul, C. (2008). Zingiberaceae Diversity in Khao Nan and Khao Luang National Parks, Nakhon Si Thammarat, Thailand. *Walailak J. Sci. Tech.* **5**(1): 17-27.

Koenig, J.G. (1783). Descriptions monandrarum pro annis. *In:* Retzius, A.J. (Ed.) *Observationes Botanicae vol 3*. Lipsiae, pp.45-76.

Kress, W.J. (1995). Phylogeny of the Zingiberanaee - Morphology and molecules. *In:* Rudall, P., Cribb, P.J., Cutler, D.F. and Humphries, C. J. (Eds.) *Monocotyledons: systematics and evolution*, pp.443–460. Royal Botanic Gardens, Kew, UK.

Kress, W. J. and Larsen, K. (2001). *Smithatris*, a new genus of Zingiberaceae from Southeast Asia. *Systematic Botany* **26**: 226-230.

Kress, W. J., Defilipps, R.A., Farr, E. and Kyi, Y.Y. (2003). A checklist of the trees, shrubs, herbs, and climbers of Myanmar. *Contributions from the United States National Herbarium* **45**: 1–590.

Kress, W. J., Prince L.M. and Williams, K.J. (2002). The phylogeny and new classification of the gingers (Zingiberaceae): Evidence from Molecular data. *Amer. J. Bot.* **89**(11): 1682-1696.

Kress, W.J., Prince, L.M., Hahn, W.J., and Zimmer, E.A. (2001). Unraveling the evolutionary radiation of the families of the Zingiberales using morphological and molecular evidence. *Systematic Biology* **51**: 926–944.

Kritikar, K.R. and Basu, B.D. (2007). *Indian Medicinal Plants Vol. 4* (2nd edition). International Book Distributers, Dehradun, India.

Kumar, S. (2001). *Zingiberaceae of Sikkim*. Deep Publication, New Delhi, 83p.

Kuntze, C.E.O. (1891). *Revisio generum plantarum Vol 1 & 2*. Felix, Leipzig.

Kurup, P.N.V., Rarndas, V.N.K. and Joshi, P. (1979). *Handbook of Medicinal Plants.* Oxford & IBH publishing Co. Pvt., New Delhi.

Kuttan, R., Bhanumati, P., Nirmala, K. and George M.C. (1985). Potential anticancer activity of turmeric (*Curcuma longa*). *Cancer Letters* **29**:197-202.

Lalfakzuala, R., Lalramnghinglova, H. and Kayang, H. (2007). Ethnobotanical usage of plants in Western Mizoram. *Ind. J. Traditional Knowledge* **6**(3): 486-493.

Lalramnghinglova, H. (2003). *Ethnomedicinal Plants of Mizoram.* Bishen Singh Mahendra Pal Singh, Dehra Dun, India, 333pp.

Lamxay, V. (2011). *The genus Amomum (Zingiberaceae) in Cambodia, Laos and Vietnam-Taxonomy and Ethno-botany with special emphasis on Women's health*. ACTA Universitatis Upsaliensis Uppsala, 40pp.

Langer, E., Greifenberg, S. and Gruenwald, J. (1998). Ginger: History and use. *Advance in Therapy* **15**: 25-44.

Larsen, K. (1964). Studies in Zingiberaceae IV. *Caulokaempferia*, a new genus. *Botanisk Tidsskrift* **60**: 165-179.

Larsen, K. (1973). Studies in Zingiberaceae VI. *Botanisk Tidsskrift* **68**: 157-159.

Larsen, K. (1996). A preliminary checklist of the Zingiberaceae of Thailand. *Thai Forest Bull. Bot.* **24**: 35–49.

Larsen, K. (1996). The Zingiberaceae in the Malesian region. *In:* Wu, T.L., Wu, Q.G., Chen, Z.Y. (Eds) *Proceedings of the 2nd Symposium on the Family Zingiberaceae*, pp.10-14. Zhongshan University Press, Guangzhou.

Larsen, K. (1997). Further studies in the genus *Boesenbergia* (Zingiberaceae). *Nord. J. Bot.* **17**: 361–366.

Larsen, K. (2003). The Zingiberaceae in Flora of Thailand. *In:* Chantaranothai, P., Larsen, K., Sirirugsa, P. and Simpson, D. (Eds) *Proceedings of the third symposium on the family Zingiberaceae*, pp.1-5. Khon Kaen University.

Larsen, K. and Larsen, S.S. (2006). *Gingers of Thailand.* Queen Sirikit Botanic Garden, Botanical Garden Organization, Ministry of Natural Resources and Environment, Chiang Mai, 184pp.

Larsen, K. and Mood, J. (1998). *Siamanthus*, a new genus of Zingiberaceae from Thailand. *Nord. J. Bot.* **18**: 393-397.

Larsen K, and Saksuwan, S. (2006). *Gingers of Thailand.* Queen Sirikit Botanic Garden, the Botanical Garden Organization, Ministry of Natural Resources and Environment, Chiang Mai, 184p.

Larsen, K. and Smith, R.M. (1972). Notes on *Caulokaempferia*. *Notes Roy. Bot. Gard. Edinburgh* **31**: 287-295.

Larsen, K. and Jenjittikul, T. (2001). *Laosanthus*, a new genus of Zingiberaceae from Laos. *Nor. J. Bot.* **21**: 135-138.

Larsen, K., Ibrahim, H., Khaw, S.H. and Saw, L.G. (1999). *Gingers of Peninsular Malaysia and Singapore*. Natural History Publications (Borneo), Kota Konabalu, pp.116-117.

Larsen, K., Lock, J. M., Maas, H. and Maas, P. J. M. (1998). Zingiberaceae. *In:* K. Kubitzki (Ed) *The families and genera of vascular plants, Vol.4*. pp. 474-495. Springer-Verlag, Berlin, Germany.

Linnaeus, C. (1753). *Species Plantarum Vol. 2.* Laurentius Salvius, Stockholm.

Lorrain, J.H. (1940). *Dictionary of the Lushai Language.* The Asiatic Society, Calcutta, 579p.

Lorrain, R.A. (1921). *Five Years in Unknown Jungles.* Lakher Pioneer Mission, London, Spectrum Publication, Gauhati (Reprint 1988), pp.88-109.

Mabberley, D. J. (1997). *The Plant Book.* Cambridge University Press, England.

Madulid, D.A. (1996). The family Zingiberaceae and the "Flora of the Philippines" project. *In:* Wu, T.L., Wu, Q.G. and Chen, Z.Y. (Eds.) *Proceedings of the 2nd Symposium on the Family Zingiberaceae,* pp. 1-9. Zhongshan University Press, Guangzhou.

Mahindru, S.N. (1982). *Spices in Indian Life*. Sultan Chand & Sons, Delhi.

Mangaly, J.K. and Sabu, M. (1992). A taxonomic revision of South Indian *Alpinia* Roxb. (Zingiberaceae). *Rheedea* **2**: 38-51.

Martin, G.J. (1995). *Ethnobotany: A conservation manual.* Chapman and Hall, London, 268pp.

Menon, K.P.P. (1929). *History of Kerela* Asian Educational Services, New Delhi (1983 reprint).

Mitra, J.N. (1958). *Flowering Plants of Eastern India Vol. 1*. World Press. Calcutta.

Moo, C.T. (1978). Zingiberaceae. *In:* Li, H.L., Liu, T.S., Huang, T.C., Koyama, T. and DeVol, C.E (Eds) *Flora of Taiwan Vol. 5,* pp.831-853. Department of Botany, National Taiwan University, Epoch Publ. Co., Taipei, Taiwan.

Mood, J. and Larsen, K. (1997). *Cornukaempferia*, a new genus of Zingiberaceae from Thailand. *Natural History Bulletin of the Siam Society* **45:** 217-221.

Nadkarni, K.M. (1976). *Indian Materia Medica with ayurvedic, unani, siddha, allopathic, homeopathic, naturopathic & home remedies Vol. 2* (Revised and enlarged, 3rd edn.). Popular Prakashan, Bombay, 968pp.

Nadkarni, K.M. (1982). *Indian Materia Medica Vol. 1* (3rd ed.). Popular Prakashan Pvt. Ltd., Bombay, pp.1292-1294.

Nadkarni, K. M. (1998). *Indian Medicinal Plants and Drugs- with their Medicinal Properties and Uses*. Asiatic Publishing House, New Delhi, 450pp.

Nayab, R., Aingorn, H., Fallavollita, L., Sallon, S., Mechoulam, R., Ginsburg, I., Vlodavsky, I. and Brodt, P. (2004). PADMA-28, a traditional Tibetan herbal preparation, blocks cellular responses to bFGF andIGF-I. *Inflammopharmacol* **12**(4): 373-389.

Nayar, M.P. and Sastry, A.R.K. (1987). *Red Data Book of Indian Plants (Vol.1-3).* Botanical Survey of India, Kolkata.

Newman, M.F. (1995). *Distichochlamys*, a new genus from Vietnam. *Edin. J. Bot.* **52**: 65-69.

Ngamriabsakul, C., Newman, M. F. and Cronk, Q. C. B. (2000). Phylogeny and disjunction in *Roscoea* (Zingiberaceae). *Edin. J. Bot.* **57**: 39-61.

Nishimura, T.B. and Suzuki, E. (2000). Spatial distributions of ginger species at tropical submontane forest floor. *Tropics* **9**: 103–116.

Othman, R., Ibrahim, H., Mohd, M.A., Awang, K., Gilani, A.U.H. and Mustafa, M.R. (2002). Vasorelaxant effects of ethyl cinnamate isolated from *Kaempferia galanga* on smooth muscles of the rat aorta. *Planta Medica* **68**: 655-657.

Owais, M. (2009). *Clinical evaluation of herbal medicine for the treatment of rheumatoid arthritis.* M. Phil thesis, Hamdard University, Karachi.

Pachuau, R. (1994). *Geography of Mizoram*. R.T. Enterprise, Aizawl, Mizoram, India, pp.1-67.

Parry, J.W. (1969) *Handbook of Spices Vol.1.* Chemical Publication Co., New York.

Parry, N.E. (1932). *The Lakhers* (Reprinted 1976). Firma KLM Private Limited on behalf of Tribal Research Institute, Aizawl, Mizoram, pp.231-579.

Perry, L.M. (1980). *Medicinal plant of East and Southeast Asia: Attributed properties and uses.* The MIT Press, Massachusetts, USA, pp.439.

Petersen, O.G. (1889). Musaceae, Zingiberaceae, Cannaceae, Marantaceae. *In:* Engler, A. and Prantl, K. (Eds.) *Die Natu¨rlichen Pflanzenfamilien* (1st ed.) **2**(6): 1–43.Verlag von Wilhelm Engelmann, Leipzig, Germany.

Phukan, J.N. (1992). The Late Home of Migration of the Mizos. *In:* Hluna, J.V., Sangkima, and Buragohain, R. (eds) *Minority nationalities of Northeast India-The Mizos.* Seminar Committee, Directorate of Higher & Technical Education, Government of Mizoram, pp.8-9.

Pongbunrod, S. (1979). *Mai-Tet-Murng-Thai: Medicinal characteristic of foreign and Thai traditional medicines.* (1st ed.) Khrungthon Press, Bangkok, Thailand, pp.493.

Poulsen, A.D., Mood, J. and Ibrahim, H. (1999). Three new species of *Etlingera* (Zingiberaceae) from Borneo. *Nor. J. Bot.* **19**: 139-147.

Prajapati, N.D., Purohit, S.S., Sharma, A.K. and Kumar, T. (2003). *A handbook of medicinal plants: A complete source book*. Agro Bios, New Delhi, 529pp.

Prakash, A. and Singh, K.K. (2001). Eukaryotic translesion synthesis DNA polymerases. *J. Med. Aroma. Pl. Sci*. **22-23**: 519.

Prakash, V. and Mehrotra, B.N. (1996a). Zingiberaceae of North-East India: Diversity and taxonomic status. *In:* Wu, T.L., Wu, Q.G. and Chen, Z.Y. (Eds.) pp.262-273. *Proceedings of the Second Symposium on the Family Zingiberaceae* South China Institute of Botany, Zhongshan University Press, Guangzhou,China.

Prakash, V. and Mehrotra, B. N. (1996b). Zingiberaceae of India: Biological screening and ethnobotanical diversity. *In:* Wu, T.L., Wu, Q.G. and Chen, Z.Y. (Eds.) pp. 229-237. *Proceedings of the Second Symposium on the Family Zingiberaceae*, South China Institute of Botany, Zhongshan University Press, Guangzhou, China.

Prasad, S. and Aggarwal, B.B. (2011). Turmeric, the Golden Spice: From traditional medicine to modern medicine. *In:* Benzie, I.F.F. and Wachtel-Galor, S. (Eds.) *Herbal Medicine: Biomolecular and Clinical Aspects* (2nd ed.). Boca Raton: CRC Press, LLC, USA, **13**: 259– 284.

Prasantkumar, M.G., Skornickova, J., Sabu, M. and Jayasree, S. (2005). Conservation priority and phytogeographical significance of *Rhynchanthus longiflorus* Hook.f. (Zingiberaceae): A rare, endangered species from Mizo hills, NE. India. *Current Science* **88**(2):977-980.

Purseglove, J.W. (1968). *Tropical crops Monocotyledons Vol 1 & 2*. Longmans, London, 607pp.

Purseglove, J.W., Brown, E.G., Green, C.L., and Robbins, S.R.J. (1981). *Spices Vol. 2.* Longman, London, pp.447-813.

Rahman, M.A. and Yusuf, M. (1996). Diversity, ecology and ethnobotany of the Zingiberaceae of Bangladesh. *J. Econ. Bot. Taxon.* (Additional Series) **12**: 13-19.

Rahman, M.A. and Yusuf, M. (1997). New records of Zingiberaceae for Bangladesh. *Bangladesh J. Bot.* **26**(1): 1-5.

Rahman, M.A. and Yusuf, M. (2012). Three new species of *Curcuma L.* (Zingiberaceae) from Bangladesh. *Bangladesh J. Plant Taxon.* **19**(1): 79-84.

Rahman, M.A., Uddin, S.B. and Wilcock, C.C. (2007). Medicinal plants used by Chakma tribe in Hill Tracts districts of Bangladesh. *Ind. J. Traditional Knowledge* **6**(3): 508-517.

Ramana, M.V., Tagore, J.K. and Bhattacharjee, A. (2012). Report of two medicinal and aromatic gingers from Andaman and Nicobar Islands, India. *J. Threatened Taxa* **4**(5): 2582-2586.

Rahman, S. N., Wahab, S. A. and Malek, S. N. A. (2013). *In Vitro Morphological Assessment of Apoptosis Induced by Antiproliferative Constituents from the Rhizomes of Curcuma zedoaria.* Evidence-Based Complementary and Alternative Medicine.

Rahmatullah, M., Azam, M.N.K., Pramanik, S., Sania, Rahman, S. and Jahan, R. (2012). Antihyperglycemic activity Evaluation of Rhizomes of *Curcuma zedoaria* (Christm.) Roscoe and Fruits of *Sonneratia caseolaris* (L.) Engl. *Inter. J. Pharm. Tech. Res.* **4(**1): 125-129.

Rangsiruji, A., Newman, M.F. and Cronk, Q.C.B. (2000). Origin and relationships of *Alpinia galanga* (Zingiberaceae) based on molecular data. *Edin. J. Bot.* **57**: 9–37.

Rao, A.S. and Verma, D.M. (1969). Notes on *Hedychium*, including 4 new species from Khasi & Jaintia Hills, Assam. *Bull. Bot. Surv. Ind.* **2:** 120-129.

Rao, A.S. and Verma, D.M. (1972). Materials towards a monocot flora of Assam-II (Zingiberaceae & Marantaceae). *Bull. Bot. Surv. Ind.* **14** (1-4): 114-143.

Rao, A.S. and Verma, D.M. (1974). *Curcumorpha*—a new genus of Zingiberaceae. *Bull. Bot. Surv. India* **13**: 339-341.

Raven, P.H. and Axelrod, D.I. (1974). Angiosperm biogeography and past continental movements. *Annals of the Missouri Botanical Garden* **61**:39-637.

Ravindran, P.N. and Babu, N.K. (2005). *Ginger-The Genus Zingiber Medicinal and aromatic plants - industrial profiles Vol-41*. CRC Press, Washington DC, 552pp.

Ravindran, P.N., Babu, N.K. and Sivaraman, K. (2007). *Turmeric: The Genus Curcuma.* CRC Press, pp.11.

Reddy, L.J., Jose, B. and Ruveena, T.N. (2011). Evaluation of Antibacterial activity of the seed essential oil and leaf extracts of *Alpinia galanga* (L.) Willd. *Asian J. Biochemical and Pharmaceutical Research* **3**(1): 270-276.

Rheede H.A. van. (1678-1693). *Hortus Indicus Malabaricus Vols. 1-12*. Amsterdam.

Rishwan, S. and Setyowati, P.M. (1996). Ethnobotanical study of Zingiberaceae in Indonesia. *In:* Wu, T.L., Wu, Q.G. and Chen, Z.Y. (Eds.) pp.196-218. *Proceedings of the*

Second Symposium on the Family Zingiberaceae, South China Institute of Botany, Zhongshan University Press, Guangzhou, China.

Rosengarten, F.J. (1969). *The Book of Spices*. Livingston Publishing Co., Pennsylvania, USA, 250pp.

Roxburgh, W. (1795-1820). *Plants of Coast of Coromandel Vol 3*. W. Bulmer and co., London, 370pp.

Roxburgh, W. (1820-1824). *Flora Indica Vol. 1-2* (1st ed.). Mission Press, Serampore.

Rozika, R. (2001). *Ramhmul Damdawite (Medicinal Plants).* Directorate of Agriculture & Minor Irrigation, Aizawl, Mizoram, 244p.

Rui, A. (1992). A comparative study of the *Mizos* in India and the WA Nationality in China: Their migratory routes. *In:* Hluna, J.V., Sangkima, and Buragohain, R. (Eds.) pp.13. *Minority nationalities of Northeast India-The Mizos.* Seminar Committee, Directorate of Higher & Technical Education, GOI, Aizawl, Mizoram.

Sabu, M. (2006). *Zingiberaceae and Costaceae of South India.* Indian Association for Angiosperm Taxonomy, Kerela, India, 282pp.

Saensouk, S. and Larsen, K. (2001). *Boesenbergia baimaii*, a new species of Zingiberaceae from Thailand. *Nor. J. Bot.* **21**: 595-597.

Saikia, N. and Nath, S.C. (2003). Ethnobotanical observations of some species of the genus *Curcuma* L. growing in Assam. *J. Eco. Taxon. Bot.* **27**: 430-433.

Saithantluanga, H. (1997). Characterization of Acid Soils of Mizoram, Ph.D. Thesis. Agricultural Chemistry & Soil Science, Orissa University of Agricultural & Technology, Bhubaneswar, Orissa, pp.74-80.

Sajem, A.L. and Gosai, K. (2006). Traditional use of medicinal plants by the Jaintia tribes in North Cachar Hills district of Assam, northeast India. *J. Ethnobiology and Ethnomedicine* **2**:33-39.

Sajithlal, G.B., Chittra, P. and Chandrakesan, G. (1998). Effect of Curcumin on the advanced glycation and cross-linking of collagen in diabetic rats. *Biochemical Pharmacology* **56**: 1607-1614.

Sakai, S. and Nagamasu, H. (1998). Systematic studies of Bornean Zingiberaceae: I. *Amomum* in Lambir Hills, Sarawak. *Edin. J. Bot.* **55**: 45-64.

Sakai, S. and Nagamasu, H. (2000). Systematic studies of Bornean Zingiberaceae: III. *Tamijia*, a new genus. *Edin. J. Bot.* **57**:245-255.

Sakhanokho, H.F., Sampson, B.J., Tabanca, N., Wedge, D.E., Demirci, B., Baser, K.H.C., Bernier, U.R., Tsikolia, M., Agramonte, N.M., Becnel, J.J., Chen, J., Rajasekaran, K. and Spiers, J.M. (2013). Chemical Composition, Antifungal and Insecticidal Activities of Hedychium Essential Oils. *Molecules* **18**: 4308-4327.

Saleh, M.M., Kamal, R.M. and Abdulla, W.A. (1982). A contribution to the molluscicidal activity of *Hedychium gardinarum*. *Planta Medica* **45**(7): 166.

Salvi, N.D., George, L. and Eapen, S. (2000). Direct regeneration of shoots from immature inflorescence cultures of turmeric. *Plant Cell Tissue and Organ Culture* **62**: 235-238.

Samant, S.S. and Palni, L.M.S. (2000). Diversity, distribution and indigenous uses of essential oil yielding medicinal plants of Indian Himalayan region. *J. Medicinal and Aromatic Plant Sci.* **22**: 671- 684.

Sangkima, (1992). A study of the Mizos with reference to their Early Home. *In:* Hluna, J.V., Sangkima, and Buragohain, R. (Eds.) *Minority nationalities of Northeast India-The Mizos.* Seminar Committee, Directorate of Higher & Technical Education, Government of Mizoram.

Saptawna, (1990). *Medicinal plants and selected traditional medicines (Damdawi kungte leh Tualchhuak damdawi thlanchhuah).* Bawlkunga, Tahan-Kalemyo, 217pp.

Sawmliana, M. (2003). *Plants of Mizoram.* Zakhuma P. Aizawl, Mizoram. 285pp.

Saralamp, P., Chuakul, W., Temsiririrkkul, R. and Clayton, T. (1996). *Medicinal Plants in Thailand Vol-1.* Amarin Printing and Publishing Public Co., Ltd., Bangkok.

Sarangthem, K. and Haokip, M.J. (2010). Bioactive components in *Curcuma caesia* Roxb. grown in Manipur. *The Bioscan* **5**(1):113-115.

Sarkar, K. and Nandy, D.R. (1976). *Structure and tectonics of Tripura - Mizoram area, India.* GSI Misc. Publications No. 31 Part-I, pp.141-145.

Sasikumar, B. (2005). Genetic resources of *Curcuma*: Diversity, characterization and utilization. *Plant Genetic Reource* **3**:230-251.

Schumann, K. (1904). Zingiberaceae. *In:* Englar, A. (Ed.) *Das Pflanzenreich IV(46) (Heft 20)* pp.1-458. Engelmann, Leipzig, Berlin, Germany.

Searle, R.J. and Hedderson, T.A.J. (2000). A preliminary phylogeny of the Hedychieae tribe (Zingiberaceae) based on ITS sequences of the nuclear rRNA cistron. *In:* Wilson, K.L. and Morrison, D.A. (Eds.) pp.710-718. *Monocots - Systematics and evolution*. CSIRO Publishing, Collingwood, Australia.

Sen, S. (1992). *Tribes of Mizoram, Description, Ethnology & Bibliography (1840-1990).* Giant Publishing House, New Delhi, pp.67-72 & 75-90.

Shakespeare, J. (1912). *The Lushei-Kuki Clans.* Cultural Publishing House, New Delhi (Reprint 1983). Giant Offset Printers, Delhi, pp.1-228.

Shankaracharya, N.B. (1982). Mango ginger. *Indian Cocoa, Arecanut and Spices Journal* **5**: 78-80.

Sharma, E., Sharma, R. and Singh, K.K. (2000). A boon for mountain populations: Large cardamom farming in the Sikkim Himalaya. *Mountain Research and Development* **20**(2): 108-111.

Shirgurkar, M.V., John C.K. and Nadgauda, R.S. (2001). Factors affecting in vitro micro-rhizome production in turmeric. *Plant Cell, Tissue and Organ Culture* **64**: 5-11.

Shrotriya, S., Ali, M.S., Saha, A., Bachar, S.C. and Islam, M.S. (2007). Anti-inflammatory and analgesic effects of *Hedychium coronarium* Koen. *Pak. Jour. Pharm. Sci.* **20**(1): 47–51.

Singh, K.S. (1995). *People of India: Mizoram Vol. 33.* Anthropological Survey of India, Seagull Books, Calcutta, pp.40-164.

Singh, N.P., Singh, K.P. and Singh, D.K. (2002). *Flora of Mizoram Vol-1*. Botanical Survey of India, Kolkata, pp.34-85.

Singh, O.P. and Datta, B. (1989). Morphology, physical and physio-chemical properties of Hill soils of Mizoram in relation to altitude. *Indian J. Hill Farming* **2**(1):9-20.

Singh, S.K. and Kumar, R. (2011). *Globba wardii* (Zingiberaceae) - a very rare species, new record for India. *Taiwania* **56**(3): 261-264.

Sirirugsa, P. (1996). The genus *Curcuma* of Thailand. *In:* Wu, T.L., Wu, Q.G., Chen, Z.Y. (Eds.) *Proceedings of the 2nd Symposium on the Family Zingiberaceae.* Zhongshan University Press, Guangzhou.

Sirigusa, P. (1997). Thai Zingiberaceae: Species diversity and their uses. *In: Proceedings of the international conference on biodiversity and bioresources: Conservation and utilization*, pp.20-27. National Science and Technology Development Agency, Phuket, Thailand.

Sirirugsa, P. (2001). Zingiberaceae of Thailand. *In:* Baimai, V. and Kumhom, R. (Eds.) *BRT Research Reports 2001: Biodiversity Research and Training Program*, pp. 63-77. Jirawat Express Co., Ltd., Bangkok, Thailand.

Sirirugsa, P. and Larsen, K. (1995). The genus *Hedychium* (Zingiberaceae) in Thailand. *Nor. J. Bot.* **15**:301–304.

Skaria, B.P., Joy, P.P., Mathew, G. and Mathew, S. (2005). Zingiberaceous plants in traditional medicine. *In: Proceedings of National seminar on 'Role of medicinal and aromatic plants inayurveda, unani and siddha systems of medicine*, pp.15-20. CCS Haryana Agriculture University, Hissar.

Skornickova, J.L., Sabu, M., and Prasanthkumar, M.G. (2003). A new species of *Curcuma* L. (Zingiberaceae) from Mizoram, India. *Gard. Bull. Sing.* **55:** 89-95.

Skornickova, J.L., Sida, O., Sabu, M., and Marhold, K. (2008). Taxonomic and nomenclatural puzzles in Indian *Curcuma*: the identity and nomenclatural history of *C. zedoaria* (Christm.) Roscoe and *C. zerumbet* Roxb. (*Zingiberaceae). TAXON* **57** (3): 949-962.

Smith, R.M. (1985). A review of Bornean Zingiberaceae:1 (Alpineae). *Notes on Royal Bot. Gard. Edin*. **42**: 261-314.

Smith, R. M. (1990). *Alpinia* (Zingiberaceae): A proposed new infra-generic classification. *Edin. J. Bot.* **47**: 1-75.

Smith, R.M. (1994). Zingiberaceae. *In*: Noltie, H.J. (Ed.) *Flora of Bhutan Vol. 3 Part 1*. Royal Botanic Gardens Edinburgh, Edinburgh, pp.182-209.

Somadeva (1981). The genus *Globba* (Zingiberaceae) from Dehradum and Garhwal Himalaya, India. *Ind. J. Forestry* **4**: 230-235.

Specht, C.D., Kress, W.J., Stevenson, D.W. and Desalle, R. (2001). A molecular phylogeny of Costaceae (Zingiberales). *Molecular Phylogeny and Evolution* **21**: 333-345.

Srivastava, S.K. (1998). Zingiberaceae in Andaman and Nicobar Islands, India. *Ind. J. Forestry* (Add. Series) **8**: 1-33.

Srimal, R.C., Sharma, S.C. and Tandon, J.S. (1984). Anti inflammatory and other pharmacological effects of *Hedychium spicatum* (Buch-Hem). *Ind. J. Pharmacology* **16**(3): 143-147.

Subrahmanyam, N.S. (2005). *Modern Plant Taxonomy*. Vikash Publishing House pvt. Ltd., New Delhi, 494pp.

Sudsai, T., Prabpai, S., Kongsaeree, P., Wattanapiromsakul, C. and Tewtrakul, S. (2014). Anti-inflammatory activity of compounds from *Boesenbergia longiflora* rhizomes. *J. Ethnopharmacology* **154**(2): 453-461.

Swapna, T.S., Binitha, M., Manju, T.S., (2004). In vitro multiplication in *Kaempferia galanga* L. *Applied Biochemistry and Biotechnology* **118**(1/3): 233-242.

Syamkumar, S. and Sasikumar, B. (2007). Molecular marker based genetic diversity analysis of *Curcuma sp.* from India. *Scientia Horticulturae* **112**(2):235-241.

Tag, H., Das, A.K. and Loyi, H. (2007). Anti-inflammatory plant used by Khamti tribes of Lohit District In Arunachal Pradesh. *Natural Product Radiance* **6**(4): 340-343.

Tane, P., Tatsimo, S.D., Ayimele, G.S., and Connolly, J.D., (2006). Bioactive metabolites from *Aframomum sp. In: 11th NAPRECA Symposium Books on Proceedings,* pp.214-223. Antananarivo, Madagascar.

Tewtrakul, S., Subhadhirasakul, S., Puripattanavong, J. and Panphadung, T. (2003). HIV-1 protease inhibitory substances from the rhizome of *Boesenbergia pandurata* Holtt. *Songklanakarin J. Sci. Tech*. **25**: 503-508.

Thanga, L.B. (1978). *The Mizos: A study in Racial Personality*. United Publishers, Gauhati, pp.1-179.

Thanga, L.B. (1992). The Mizo Identity and Mizoram. *In:* Hluna, J.V., Sangkima, and Buragohain, R. (Eds.) *Minority nationalities of Northeast India-The Mizos,* pp.143-144. Seminar Committee, Directorate of Higher & Technical Education, Government of Mizoram.

Theilade, I. and Mood, J. (1997). Five new species of *Zingiber* (Zingiberaceae) from Borneo. *Nor. J.Bot.* **17**: 337-347.

Thingam, B., Konsam, B. and Sarangthem, N. (2013). *Globba sherwoodiana* (Zingiberaceae) - A new record for India from Manipur. *Rheedea* **23**(1):34-36.

Thomas, V.P. and Sabu, M. (2012a). Two new species of *Amomum* (Zingiberaceae) from Western Ghats, India. *Edin. J. Bot.* **69**(2): 313-321.

Thomas, V.P. and Sabu, M. (2012b). *Amomum nilgiricum* (Zingiberaceae), a new species from Western Ghats, India. *Phytokeys* **8**: 99-104.

Thomas, V.P., Dan, M., Sabu, M. and M.A. Jabbar. (2010). *Amomum andamanicum*: (Zingiberaceae) a new species from the Andaman Islands, India. *Blumea* **55**: 295-299.

Thomas, V.P., Sabu, M. and Gupta, U. (2009). Taxonomic studies on cultivars of *Amomum subulatum* (Zingiberaceae). *Rheedea* **19**(1&2): 25-36.

Thomas, V.P., Sabu, M. and Lalramnghinglova, H. (2013). *Amomum dampuianum and Amomum mizoramense* spp. nov. (Zingiberaceae) from Mizoram, North-East India. *Nor. J. Bot.* **31**:561-568.

Thongam, B., Sarangthem, N. and Konsam, B. (2011). *Globba schomburgkii* Hook.f. (Zingiberaceae): A new record from Manipur, Northeast India. *Folia Malaysiana* **12**(1): 39-42.

Tripathi, S. and Prakash, V. (1999). *Amomum jainii* spp. nov. (Zingiberaceae) from N.E. India. *Nor. J. Bot.* **19**(5): 609-611.

Tripathi, S. and Prakash, V. (2000). A new species of *Amomum* Roxb. (Zingiberaceae) from Meghalaya, N.E. India. *Edin. J. Bot.* **57**(2): 257-259.

Tripathi, S. and Prakash, V. (2000). A new species of *Amomum* Roxb. from Meghalaya, India. *Rheedea* **9**(2): 177-180.

Tripathy, S. and Singh, K.K. (2006). Taxonomic revision of the genus *Zingiber* Boehm. in North East India. *J. Economic and Taxonomic Bot.* **30(**3): 520-532.

Trivedi, P.C. (2003). *Ethnomedicinal plant of India.* Aviskar Publisher, Jaipur, pp.46.

Tuchinda, P., Reutrakul, V., Claeson, P., Pongprayoon, U., Sematong, T., Santisuk, T. and Taylor, W.C. (2002). Anti-inflammatory cyclohexenyl chalcone derivatives in *Boesenbergia pandurata*. *Phytochemistry* **59**: 169-173.

Teuscher, E. (2006). *Medicinal spices-A Handbook of Culinary Herbs, Spices, Spice Mixtures and their essential oils.* Stuttgart Med-pharm Scientific Publishers, pp.182-188.

USDA (1988). *Soil Taxonomy: A basic classification for making and interpreting soil surveys.* US Department of Agricultural Soil Conservation Service, Robert E. Krieger Publishing Company, Malabar, Florida, pp.179-373

Valenzuela, H. (2011). Farm and Forestry Production and Marketing Profile for Ginger (Zingiber officinale). *In:* Elevitch, C.R. (Ed.). *Specialty Crops for Pacific Island Agroforestry*. Permanent Agriculture Resources (PAR), Holualoa, Hawaii.

Valeton, T.H. (1918). New notes on the Zingiberaceae of Java and Malaya. *Bull. Jardin Botanique de Buitenzorg* **2**(27): 1-81.

Verghese, J. (1990). Mango ginger - an exotic flavourant. *Indian Spices* **27**:15-16.

Van Rheede, H. (1692). *Hortus Indicus Malabaricus Vol-11*. Amsterdam.

Vasudeva Rao, M.K. (1986). A preliminary report on the angiosperms of Andaman and Nicobar Islands. *J. Econ. Taxon. Bot*. **8**(1): 107-184.

Wallich, N. (1828-49). *A numerical list of dried specimens of plants in the East Indian Company's Museum.* London.

Wallich, N. (1830-1832). *Plantae Asiaticae Rariores Vol. 3*. London.

Wang, J.C. (2000). Zingiberaceae. *In:* Editorial Committee of the Flora of Taiwan (Eds) *Flora of Taiwan Vol. 5* (2^{nd}ed.). Department of Botany, National Taiwan University, Taipei, pp.707-724

Warren, K.S. and Peters, P.A. (1968). Cercariae of *Schistosoma mansoni* and plants: Attempt to penetrate *Phaseolus vulgaris* and *Hedychium coronarium* produces a cercaricide. *Nature* **217**: 647-648.

Warrier, P.K., Nambiar, V.P.K. and Ramankutty, C. (1993-1995). *Indian Medicinal Plants Vol.1-5*. Orient Longman Ltd., Madras.

Watt, G. (1872). *The Commercial Products of India.* Today & Tomorrow's Pub., Delhi (Reprint, 1966).

Weiss, E.A. (2002). *Spice crops*. CABI International, Wallingford, UK, 299p.

Westphal, E. and Jansen, P.C.M. (1989). *Plant Resources of South-East Asia. A selection.* Pudoc Scientific Publisher, Wageningen, The Netherlands, pp.32-34.

Wight, R. (1838-1853). *Icones Plantarum Indiae Orientalis*. Madras

Williams, K.J., Kress, W.J. and Tun, T. (2002). A striking new epiphytic *Hedychium* (Zingiberaceae) from Myanmar with a discussion of several anomalous related genera. *Edin. J. Bot.* **60**(1): 43-48.

Williams, K.J., Kress, W.J. and Manos, P.S. (2004). The phylogeny, evolution, and classification of the genus *Globba* and tribe *Globbeae* (Zingiberaceae): appendages do matter. *Amer. J. Bot*. **91**: 100-114.

Willis, J.C. (1948). *A dictionary of flowering plants and ferns.* Cambridge University Press.

Wilson, B., Abraham, G., Manju, V.S., Mathew, M., Vimala, B., Sundaresan, S. and Nambisan, B. (2005). Antimicrobial activity of *Curcuma zedoaria* and *Curcuma malabarica* tubers. *J. Ethnopharmacology* **99**(1): 147-51.

Womersley, J.S. (1981). Plant collection and herbarium development. A manual. *In: FAO, Plant Production and Protection Paper-33.* FAO, Rome, pp.1-137.

Wood, T.H., Whitten, W.M., and Williams, N.H. (2000). Phylogeny of *Hedychium* and related genera (Zingiberaceae) based on ITS sequence data. *Edin. J. Bot.* **57**: 261-270.

Wood, T.H. (1991). *Biogeography and the evolution of the Zingiberaceae.* Zingiberaceae Workshop, Prince of Songkla University, Hat Yai, Thailand, pp.6-7.

Wu, Te-Lin and Larsen, K. (2000). Zingiberaceae. *In:* Wu, Z.Y., Raven, P.H. (Eds) *Flora of China Vol 24.* Science Press, Beijing and Missouri Botanical Garden Press, St. Louis, pp.322-377.

Wu, Te-Lin (1985). The origin of *Zingiber officinale*. *Agricultural Archego* **2**: 247-250.

Yusuf, M. and Rahman, M.A. (2003). *Boesenbergia islamii* Yusuf and Rahman (Zingiberaceae)-A new Species from Bangladesh. *Saudi J. Biological Science* **10**(1):51-55.

Yusuf, M., Begum J., Hoque, M.N. and Chowdhury, J.U. (2009). *Medicinal Plants of Bangladesh*. BCSIR, Chittagong, 794 pp.

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Amomum dampuianum and *A. mizoramense* spp. nov. (Zingiberaceae) from Mizoram, northeast India

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Two new species of *Amomum* (Zingiberaceae) from Mizoram are described and illustrated: *A. dampuianum* and *A. mizoramense.* Photographs, a comparison with the allied species *A. corynostachyum* and *A. hypoleucum*, and a key to the species of *Amomum* known in Mizoram is also provided.

Amomum Roxb. is the second largest genus in the ginger family, with about 150–180 species, widely distributed in south and southeast Asia (Tong 1999). Recent molecular studies in *Amomum* using ITS and *matK* DNA sequence data confirm its polyphyletic integrity (Xia et al. 2004). The genus is represented by 22 species in India, and mostly restricted to northeast India, south India and Andaman and Nicobar Islands (Thomas et al. 2010).

No comprehensive revision of Indian *Amomum* has been done since Baker (1892). However, a few authors have studied Zingiberaceae in northeast India. Mitra (1958) studied the monocotyledons of eastern India and included 8 species of *Amomum*, of which two were transferred to other genera. Rao and Verma (1969, 1972) studied the monocot flora of Assam and discussed 5 taxa viz. *A. pauciflorum* Baker, *A. corynostachyum* Wall., *A. dealbatum* var. *sericeum* (Roxb.) Baker, *A. subulatum* Roxb. and *A. aromaticum* Roxb. Dam and Dam (1992) described a new species *A. deorianum* from Jaintia Hills of Meghalaya, and Tripathi and Prakash (1999a, 1999b, 2000) described three new species from the Garo Hills of Meghalaya: *A. garoense*, *A. jainii* and *A. vermanum*.

Amomum is characterized by the presence of perennial aerial shoots and the possession of a radical inflorescence. There is no involucre of sterile bracts covering the inflorescence and the lateral staminodes are highly reduced. The plane of distichy of leaves is perpendicular to the rhizome and the anther crest is usually well-developed.

Recent field explorations in Mizoram state of northeast India resulted in the collection of two interesting species of *Amomum* with creeping slender rhizomes which are formally described below: *A. dampuianum* V. P. Thomas, M. Sabu & H. Lalramnghinglova looks similar to *A. hypoleucum* Thwaites and *A. mizoramense* M. Sabu, V. P. Thomas & L. Vanchhawng is similar to *A. corynostachyum*, but they differ in many characters (Table 1, 2). The specimens were brought to the 'Morphology and Taxonomy Laboratory' of Calicut Univ., and illustrations and descriptions were prepared. Delin and Larsen (2000) recorded 39 species of *Amomum* from China and similar species from their study are also discussed. *Amomum dampuianum* shows some morphological affinities with *A. maximum* group and *A. mizoramense* with *A. villosum* group in the phylogenitic grouping of Xia et al. (2004).

Specimens collected from various localities in northeast India and herbarium material deposited at CAL, CALI, ASSAM, CDRI, K, BM and LWG were used in the present study.

Amomum dampuianum V. P. Thomas, M. Sabu & H. Lalramnghinglova sp. nov. (Fig. 1, 2)

Amomo hypoleuco rhizomatibus stoloniferis gracilibus et floribus similis, sed foliis lanceolatis, laminis abaxialiter glabris, bracteis coriaceis, crista emarginata, fructibus marroninis alatis differt.

Type: India, Mizoram, Mamit district: Dampui Reserve Forest, 2 Jun 2008, V. P. Thomas, A. V. Prasanth and Lalnuntluanga Vanchhawng 113418 (holotype: CALI, isotype CAL).

Etymology

The specific epithet is derived from the name of the type locality, Dampui forest.

Description

Spreading herb. Rhizome stoloniferous, slender, 3–4 mm in diameter, creamy-white inside, covered with scales; scales

Table 1. Comparison between *Amomum hypoleucum* and *A. dampuianum* sp. nov.

Characters	*A. hypoleucum*	*A. dampuianum*
Lamina	oblanceolate to oblong-lanceolate, 30.0–70.0 × 6.5–13.5 cm, abaxial surface appressed pubescent, veins raised above	linear-lanceolate, 33.0–47.0 × 2.5–4.5 cm, abaxial surface glabrous, veins appressed above
Inflorescence	many inflorescences arising from the underground stolon	one or two inflorescences from the rhizome just below the pseudo-stem
Anther crest	semi-lunar	emarginate
Bract	membranous to chartaceous, white	coriaceous, pink
Fruits	red or green, ribbed	maroon, winged

oblong, ca 2 cm long, chartaceous, glabrous. Leafy shoots 100–150 cm tall, slender. Leaves 8–9 per shoot; sheath ca 1 cm wide at base, green, glabrous, with membranous margin; ligule 2–4 mm long, coriaceous, glabrous, truncate to emarginate at apex; petiole 2.0–3.5 cm long, green, glabrous; lamina linear-lanceolate, 33–47 × 2.5–4.5 cm, aromatic when crushed, dark green above, pale beneath, oblique at base, acuminate at apex, glabrous along margin and on both surfaces; midrib glabrous; veins appressed above. Inflorescence ca 4 cm long, one or two arises from the base of the pseudo-stem; spike 3–4 cm long, obovate-oblong; peduncle 0–1 cm long, covered with 4–6 sterile bracts; flowers well exserted from the bracts, 3–4 per inflorescence. Fertile bracts ovate, ca 2.3 × 2.2 cm, compactly arranged in two rows, coriaceous, pink, white towards base, puberulous externally, glabrous within, glabrous along margin, mucronate at apex. Bracteole open to base, ovate, 3.6–4.0 × 1.6–1.9 cm, chartaceous, white, puberulous towards apex externally, glabrous within and along margin, acute at apex. Flower 7.8–9.2 cm long, white. Calyx 3-lobed, as long as the corolla tube, 3.5–5.4 cm long, 8–9 mm in diameter, white, glabrous externally except for a few hairs near apex, glabrous within, unilaterally split, cleft ca 1.9 cm deep, with small mucro on two lobes. Corolla tube 3.8–5.4 cm long, ca 4 mm in diameter at apex, white, puberulous externally, villous near apex within; dorsal corolla lobe obovate-oblong, 3.3–3.5 × 1.3–1.4 cm, white, glabrous on both surfaces but with margin ciliate towards base, mucronate at apex; lateral corolla lobes lanceolate, 3.0–3.4 × 1.0–1.3 cm, white, glabrous on both surfaces, distantly ciliate towards lower margin. Labellum 4.0–4.2 cm long, apex ca 2.7 cm broad, white, median part red from the base to middle and with yellow patch above, with wavy crumbled margin, clawed to base; claw ca 1.7 cm long, 8 mm broad at its widest point, pubescent from base to middle internally. Lateral staminodes subulate, ca 3 mm long, slightly flattened, red tinged, densely pubescent near base. Stamen 2.3–2.6 cm long; filament 0.8–1.0 × 0.2–0.3 cm, white, glabrous abaxially, pubescent adaxially; connective white, pubescent; crest emarginate, ca 3 mm long and 12 mm broad, white, glabrous; anther thecae oblong, 1.0–1.2 cm long, cream-coloured, glabrous, rounded at base; apex slightly diverging, rounded; dehiscing throughout their length. Epigynous glands 2, oblong, 1.2–1.3 cm long, cream-coloured, glabrous, acuminate at apex. Ovary oblong, 4–5 × 3 mm, pale pink, glabrous; locules 3; ovules many on axilary placentation; style 6.1–6.5 cm long, glabrous; stigma cup-shaped, ca 1.5 mm across; ostiole cilliate, facing upwards. Infructescence 3–5 cm long, with 2–3 capsules per spike; peduncle 3–4 cm long, partly embedded in the ground. Capsule globose, winged, ca 2 × 2 cm, dark maroon, glabrous; calyx not persistent. Seeds many, irregularly shaped, 3–4 × ca 3 mm, brown, glabrous, arillate; aril white, fully embedding seed.

Ecology, distribution and phenology

Amomum dampuianum is found growing as undergrowth in the evergreen forest patches. The species is collected only from Dampui Reserve Forest of Mizoram. Flowering and fruiting during March to July.

Conservation status

Amomum dampuianum is evaluated as 'Critically Endangered' according to the 2001 IUCN criteria (CR B1ab (i, ii, iii)) (IUCN 2001). The species is known to exit in Dampui forest and the extent of occurrence is estimated to be less than 100 km^2. In addition, the extent of occurrence continues to decline due to deforestation and widening of roads.

Similar species

Amomum dampuianum is similar to *A. hypoleucum* in having slender, stoloniferous rhizomes, large white flowers and 2–4 flowers in an inflorescence, but differs in many attributes, which are given in Table 1. *Amomum dampuianum* also shows similarity with the Chinese species *A. mengtzense* and *A. glabrum* in having similar type of fruits but differs in many characters. *Amomum mengtzense* has a long petiole (ca 16 cm); pubescent abaxial lamina; 2-cleft, membranous ligule; larger oblong lamina (70–100 × 12–15 cm) with

Table 2. Comparison between *A. corynostachyum* and *A. mizoramense* sp. nov.

Characters	*A. corynostachyum*	*A. mizoramense*
Habit (cm)	200–450	50–180
Lamina	28–50 × 4.0–7.5 cm, margin straight	18–25 × 3.0–5.2 cm, margin wavy
Anther crest	entire	cleft at centre
Lateral staminode	2–4 mm long	highly reduced, represented by bulbous tissue
Anther thecae	glabrous	puberulous
Fruit	smooth-walled, green or maroon	densely echinate, red

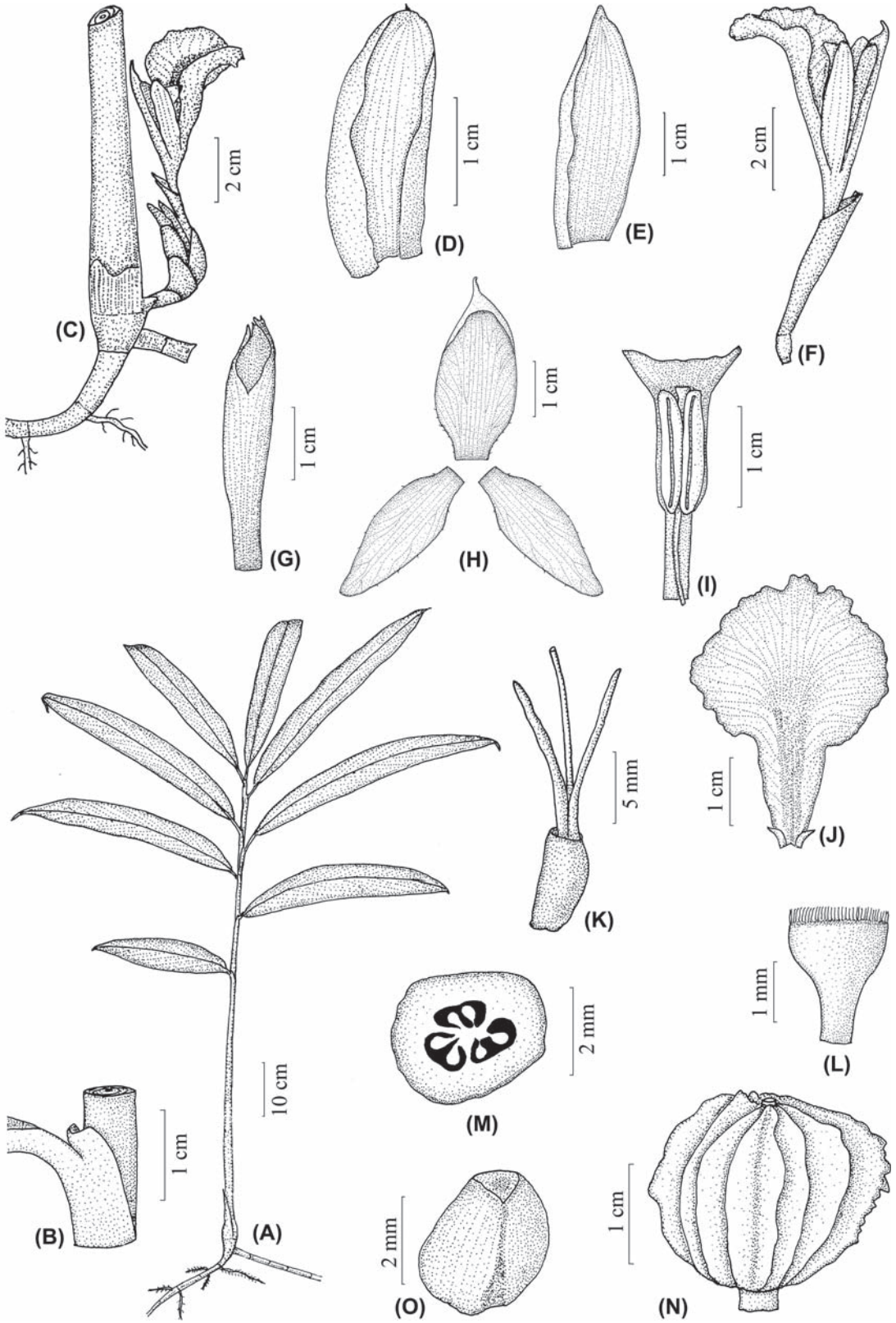

Figure 1. *Amomum dampuianum* sp. nov. (A) habit, (B) ligule, (C) inflorescence, (D) bract, (E) bracteole, (F) flower, (G) calyx, (H) corolla lobes, (I) stamen, (J) labellum, (K) ovary with epigynous glands and style, (L) stigma, (M) cross section of ovary, (N) fruit, (O) seed (aril removed).

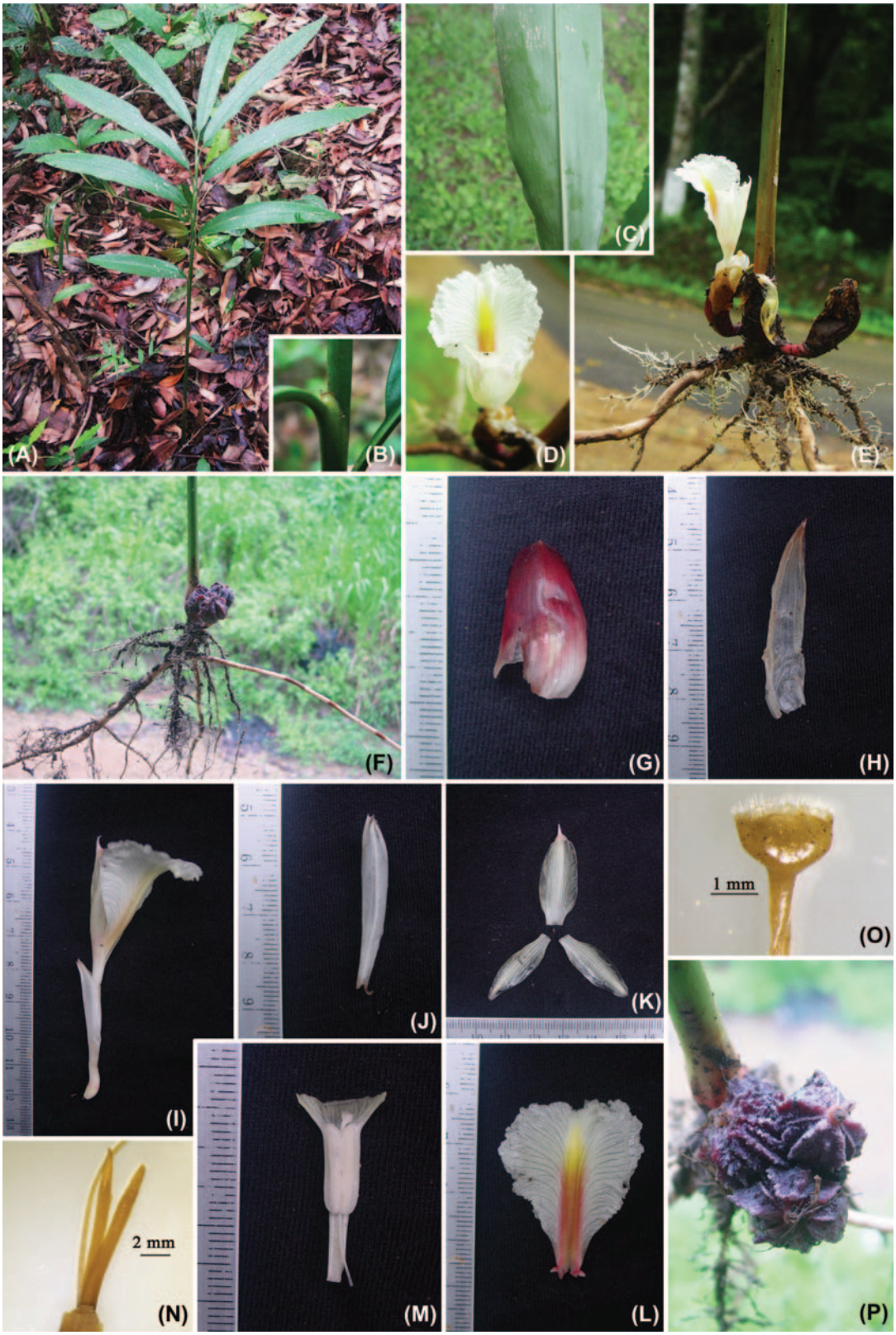

Figure 2. *Amomum dampuianum* sp. nov. (A) habit, (B) ligule, (C) leaf beneath, (D)–(E) inflorescences, (F) rhizome with infructescence, (G) bract, (H) bracteole, (I) flower, (J) calyx, (K) corolla lobes, (L) labellum, (M) stamen, (N) epigynous glands and style, (O) stigma, (P) infructescence (1 div. = 1 mm).

cuneate base; longer peduncle (30–40 cm) and fruits with persistent calyx. On the other hand, *A. dampuianum* has a short petiole (2.0–3.5 cm); glabrous lamina; truncate to emarginate coriaceous ligule; medium-sized linear-lanceolate lamina (33–47 × 2.5–4.5 cm) with oblique base. *Amomum glabrum* is characterized by a 3-lobed anther crest, cuspidate bract, 2-cleft, membranous ligule, cuneate lamina base and tubular bracteole, while the anther crest is emarginate, bract is cuspidate, ligule is emarginate to truncate and coriaceous, lamina base is oblique and bracteole is non-tubular in *A. dampuianum.*

Amomum mizoramense M. Sabu, V. P. Thomas & L. Vanchhawng sp. nov. (Fig. 3, 4)

Amomo corynostachyo rhizomatibus stoloniferis gracilibus et floribus similis, sed foliis margine undulatis, staminodio laterali reducto, antherae thecis puberulis, crista fissa, fructu echinato differt.

Type: India, Mizoram, Mamit district: Dampui Reserve Forest, 2 Jun 2008, V. P. Thomas, A. V. Prasanth and L. Vanchhawng 113421 (holotype: CALI, isotype: CAL, ASSAM).

Etymology
The specific epithet is derived from the name of the state Mizoram, where the type was collected.

Description
Spreading herb. Rhizome stoloniferous, slender, 3–5 mm in diameter, creamy-white inside, sheathed with scales; scales oblong, 1.5–2.5 cm long, pubescent externally. Leafy shoots 50–180 cm tall, slender. Leaves 10–20 leaves per shoot; sheath 2.0–2.3 cm wide at base, green, with ciliate margin, rounded at apex, pubescent externally, glabrous within; ligule truncate to emarginate at apex, 2–3 mm long, coriaceous, green, glabrous; petiole 2–5 mm long, green, glabrous; lamina elliptic to elliptic-lanceolate, 18–25 × 3.0–5.2 cm, cuneate at base, wavy along margin, at apex with a to 4 cm long acumen, curled, glabrous on both surfaces; midrib glabrous; veins appressed above. Inflorescence 6–13 cm long, many flowered, arises from the rhizome under soil; spike 2–3 cm long; peduncle 4.0–10.5 cm long. Fertile bract obovate, 2.5–3.0 × 0.6–1.8 cm, chartaceous, pale brown, pubescent externally, glabrous within, glabrous along margin, minutely mucronate at apex. Bracteole tubular, 2-lipped, 1.2–1.4 × 0.4 cm, membranous, pale pink, with one lip longer than other, pubescent externally, densely towards the base, sparsely towards apex, glabrous within, rounded at apex. Flower 3.2–3.5 cm long, white to pale yellow. Calyx 3-lobed, 1.7–2.0 cm long, ca 4 mm in diameter, white, membranous, sparsely pubescent near apex and externally, glabrous within, with mucro on two lobes; mucro 1.0–1.5 mm long. Corolla tube 1.3–1.5 long, 3–4 mm diameter at apex, pubescent externally, densely pubescent towards apex within and glabrous towards base; dorsal corolla lobe obovate, 1.5–1.7 × 0.7–0.8 cm, white, glabrous on both surfaces, with upper margins folded to form a hood, emucronate, sparsely ciliate along margin; lateral corolla lobes oblanceolate, 1.5–1.7 × 0.6–0.7 cm, glabrous on both surfaces, with lower margin sparsely ciliate and apex folded in one side. Labellum obovate, tri-lobed; median lobe slightly cleft, 1.3–1.9 cm long, pale yellow, yellow at centre, with red spots along margins of yellow centre, with wavy margin, clawed to base; claw 5–7 mm long, 4 mm broad base clawed, densely pubescent near base adaxially. Lateral staminodes highly reduced. Stamen 1.3–1.4 cm long; filament 3–4 mm, white, glabrous, rarely puberulous; connective white, glabrous; crest with a wedge-shaped cleft at centre, which often proceeds to base and split the crest into two lobes, 6–7 × ca 1 mm, pale yellow, glabrous, with wavy margins; anther thecae oblong, ca 9 × 1 mm, pale yellow, with base and apex rounded, puberulous; dehiscing throughout their length. Epigynous glands 2, oblong, ca 2 mm long, creamy-yellow, minutely lobed at apex. Ovary oblong, 6–7 × ca 3 mm, pubescent externally; locules 3; ovules many on axilary placentation; style 2.4–2.6 cm long, densely pubescent towards apex and glabrous towards base; stigma cup-shaped, ca 1 cm across, white, ostiole ciliate, facing sub-lateral. Infructescence 11–14 cm long, with 5–7 capsules per spike. Capsule sphaerical, densely echinate, 1.8–2.0 × 1.5–1.8 cm, red, pubescent; calyx persistent; pedicel ca 5 cm long. Seeds many, irregularly shaped, 3–4 × 2–3 mm, dark brown, glabrous, arillate; aril white, fully embedding seed.

Ecology, distribution and phenology
Amomum mizoramense grows as undergrowth in the evergreen forests in Lunglei and Mamit districts of Mizoram. The species flowers and fruits during March to July.

Conservation status
Amomum mizoramense is considered to be 'Endangered' according to the 2001 IUCN criteria (EN B2ab (i, ii, iii)) (IUCN 2001). It is known to exist in three localities, and the area of occupancy is estimated to be less than 500 km^2. Habitat loss is at risk due to various anthropogenic activities.

Similar species
Amomum mizoramense shows similarity with *A. corynostachyum* in having slender stoloniferous rhizomes, small flowers, long peduncle, etc. but differs in many attributes (Table 2). It also shows affinity with *A. villosum*. The anther crest is 3-lobed in *A. villosum*, whereas it has a wedge-shaped cleft at the center that often proceeds to the base and split the crest into two lobes in *A. mizoramense*.

Additional specimens examined (paratypes)
India, Mizoram, Lunglei district: Saireptlang, 7 Sep 2002, M. G. Prasanth Kumar and Jana Skornickova 86212 (CALI). Mamit district: Dampa Tiger Reserve, 4 Jun 2008, V. P. Thomas and A. V. Prasanth 113442 (CALI).

Key to the related species of *Amomum* found in Mizoram

Based on the fieldwork and herbarium specimens deposited at various herbaria, eight species of *Amomum* are recorded so far from Mizoram.

1. Rhizome stoloniferous; habit spreading …… 2
   – Rhizome non-stoloniferous; clump forming …… 6

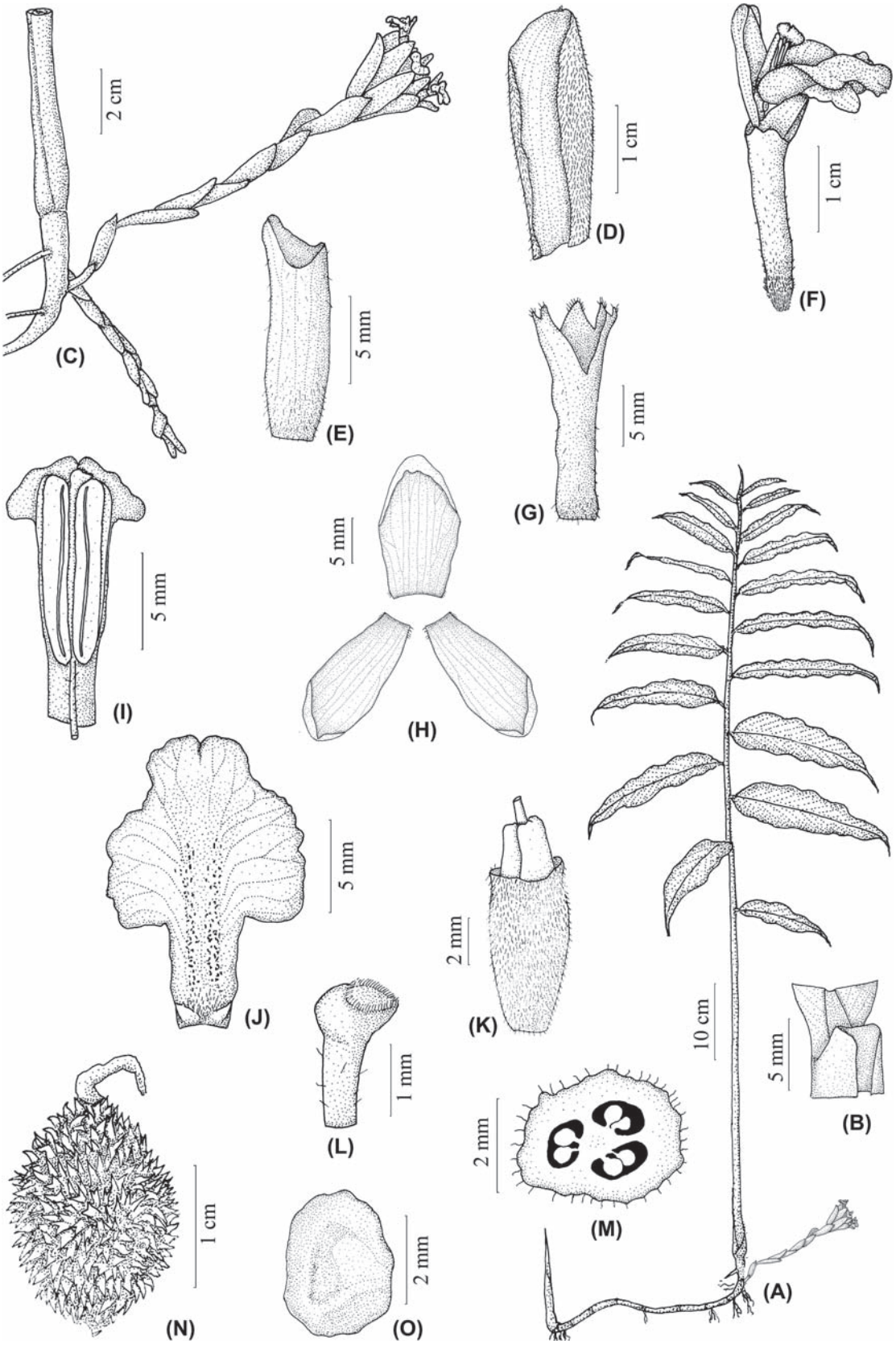

Figure 3. *Amomum mizoramense* sp. nov. (A) habit, (B) ligule, (C) inflorescence, (D) bract, (E) bracteole, (F) flower, (G) calyx, (H) corolla lobes, (I) stamen, (J) labellum, (K) ovary with epigynous glands and style, (L) stigma, (M) cross section of ovary, (N) fruit, (O) seed (aril removed).

Figure 4. *Amomum mizoramense* sp. nov. (A) habit, (B) ligule, (C) inflorescence, (D) rhizome with inflorescence, (E) bract, (F) bracteole, (G)–(H) flowers, (I) calyx, (J) corolla lobes, (K) stamen, (L) labellum, (M) stigma, (N) infructescence (1 div. = 1 mm).

2. Capsule smooth-walled …… *A. corynostachyum*
– Capsule echinate, tubercled, winged or ribbed …… 3
3. Lamina base cuneate; bracteole tubular; capsule echinate or tubercled …… 4
– Lamina base oblique; bracteole non-tubular or absent; capsule winged, ridged or faintly ribbed …… 5
4. Labellum 3-lobed with median lobe cleft; anther puberulous; capsule echinate …… *A. mizoramense*
– Labellum entire; anther glabrous; capsule tubercled …… *A. aromaticum*
5. Inflorescences many, arising simultaneously from the stolon; fruit ribbed …… *A. pauciflorum*
– Inflorescence one or two, arising from the base of pseudo-stem; fruit winged …… *A. dampuianum*
6. Lamina glabrous or appressed hairy beneath; flowers yellow …… 7
– Lamina tomentose beneath; flowers white …… *A. maximum*
7. Leaves silvery beneath; bracts perishable before anthesis; calyx without subulate horns …… *A. sericeum*
– Leaves pale green beneath; bracts not deciduous; calyx with long subulate horns …… *A. subulatum*

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References

Baker, J. G. 1892. *Amomum*. – In: Hooker, J. D. (ed.), Flora of British India. Vol. 6. L. Reeve and Co., pp. 233–243.

Dam, D. D. and Dam, N. 1992. A new *Amomum* (Zingiberaceae) from Jaintia Hills, Meghalaya. – Bull. Bot. Surv. Ind. 34: 212–214.

Delin, W. and Larsen, K. 2000. – In: Zhengyi, W. and Raven, P. H. (eds), Flora of China. Science Press, Miss. Bot. Gard. Press, pp. 347–356.

IUCN 2001. IUCN red list categories and criteria, ver. 3.1. – IUCN Species Survival Commission.

Mitra, J. N. 1958. Flowering plants of eastern India. Vol. 1. Monocotyledons. – The World Press, pp. 245–255.

Rao, A. S. and Verma, D. M. 1969. Notes on Zingiberaceae from Assam. – Bull. Bot. Surv. Ind. 2: 245–248.

Rao, A. S. and Verma, D. M. 1972. Material towards a monocot flora of Assam-II. (Zingiberaceae, Marantaceae). – Bull. Bot. Surv. Ind. 14: 114–143.

Thomas, V. P. et al. 2010. *Amomum andamanicum* (Zingiberaceae): a new species from the Andaman Islands, India. – Blumea 55: 295–299.

Tong, S. Q. 1999. Zingiberaceae. – In: Wu, Z. Y. (ed.), Flora Yuananica, Tomus 8. Science Press, pp. 528–651.

Tripathi, S. and Prakash, V. 1999a. A new species of *Amomum* Roxb. from Meghalaya, India. – Rheedea 9: 177–180.

Tripathi, S. and Prakash, V. 1999b. *Amomum jainii* (Zingiberaceae) from northeast India. – Nord. J. Bot. 19: 609–611.

Tripathi, S. and Prakash, V. 2000. A new species of *Amomum* Roxb. (Zingiberaceae) from Meghalaya, NE India. – Edinb. J. Bot. 57: 257–259.

Xia, Y. M. et al. 2004. Phylogenetic analysis of *Amomum* (Alpinioideae: Zingiberaceae) using ITS and *MatK* DNA sequence data. – Syst. Bot. 29: 334–344.

Photo Plate – I

A - C : *Alpinia aquatica* (A-Flower, B-Fruit & C-Habitat).

D - E : *Alpinia bracteata* (D-Inflorecsence & E-Habitat).

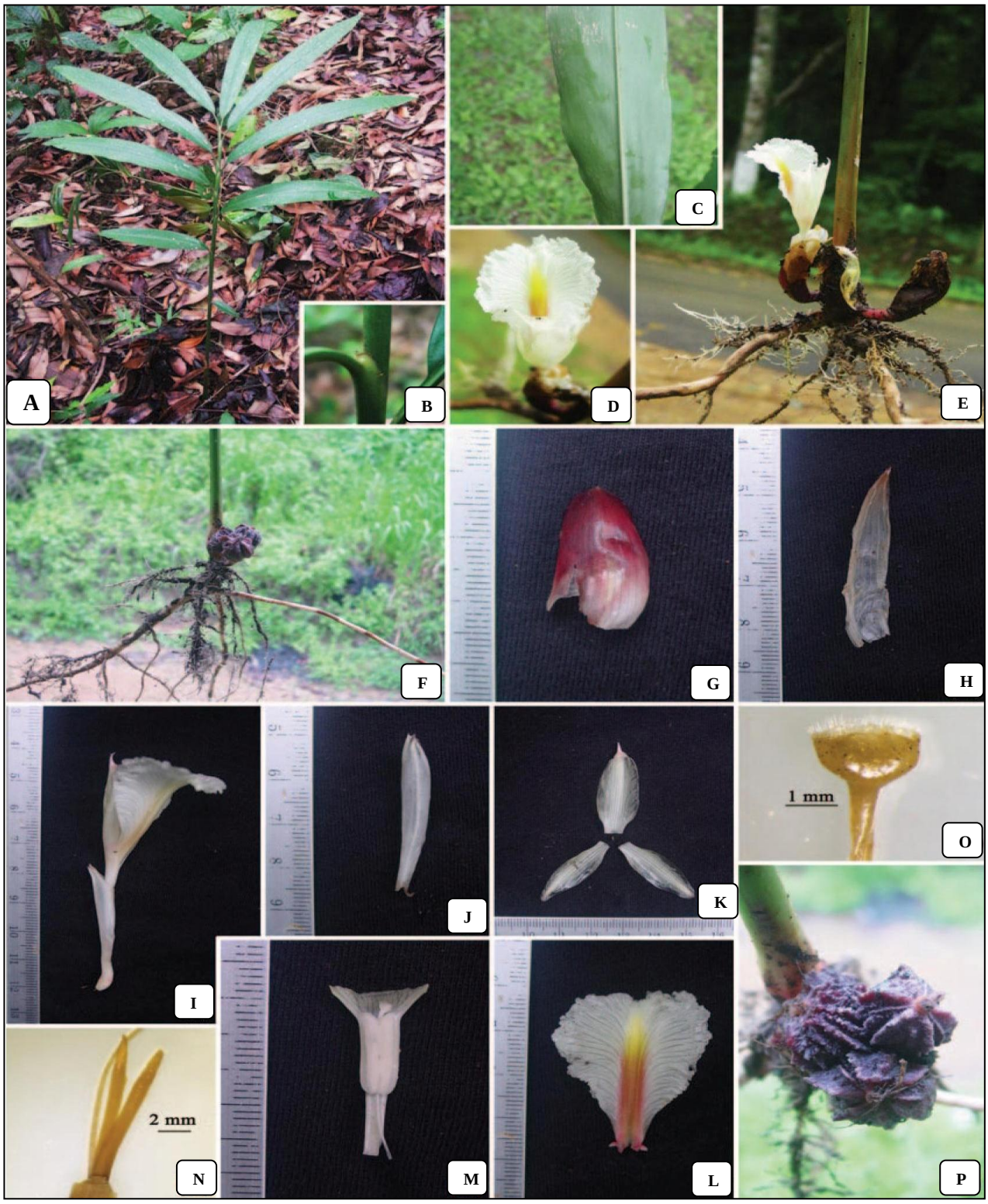
F - G : *Alpinia galangal* (F-Habitat & G-Inflorescence).

H - I : *Alpinia malaccensis* (H-Habitat & I-Flower).

Photo Plate – II

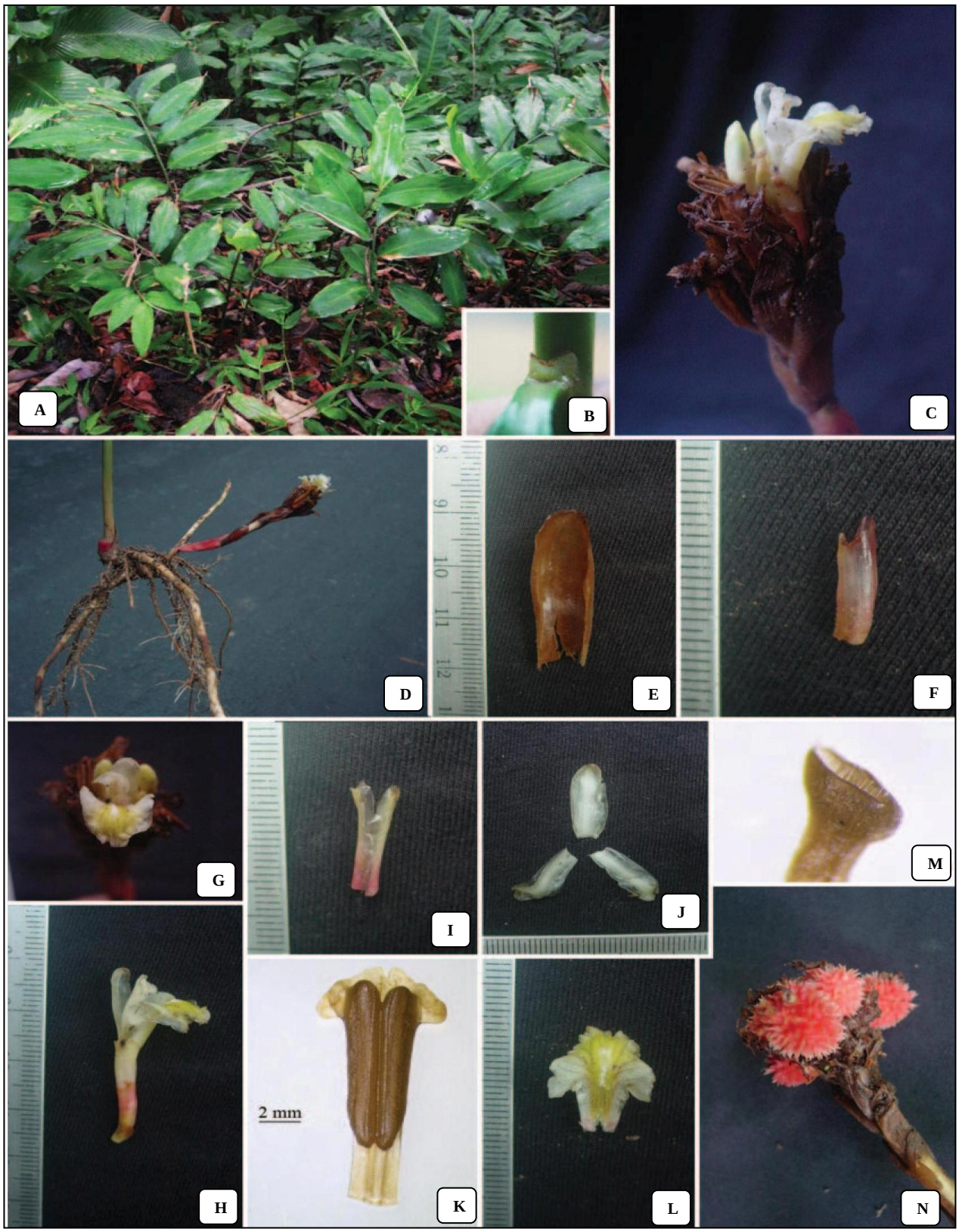
A	:	*Amomum corynostachyum* (Inflorescence).
B - D	:	*Amomum dealbatum* (B-Flower, C-Inflorescence & D-Habitat).
E - G	:	*Amomum aromaticum* (E-Inflorescence, F-Flower & G-Habitat).
H	:	*Amomum jainii* (Flower).
I	:	*Amomum aroamticum* (Flower).
J - K	:	*Amomum vermanum* (J-Fruit & K-leaves).
L - M	:	*Boesenbergis longiflora* (L-Flower & M-Habitat).
N - P	:	*Boesenbergia tiliaefolia* (N-Flower, O-Inflorescence & P-Habitat).

Photo Plate – III



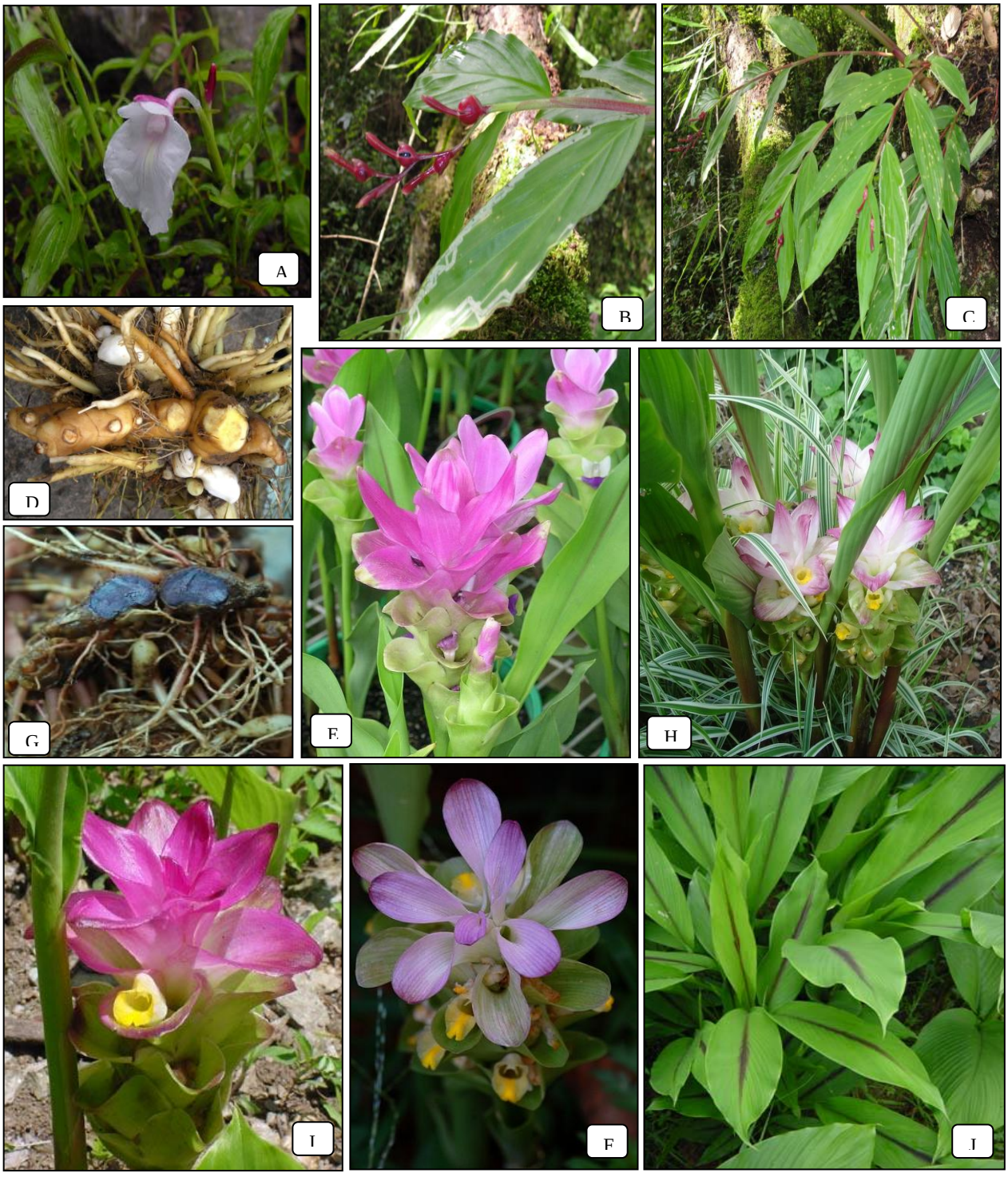
Amomum dampuianum : **A**-Habit, **B**-Ligule, **C**-Leave beneath, **D**-Flower, **E**-Inflorescence, **F**-Rhizome with infructescence, **G**-Bract, **H**-Bracteole, **I**-Calyx, **K**-Corolla lobes, **L**-Labellum, **M**-Stamen, **N**-Epigynous glands and Style, **O**-Stigma & **P**-Infructescence.

Photo Plate – IV



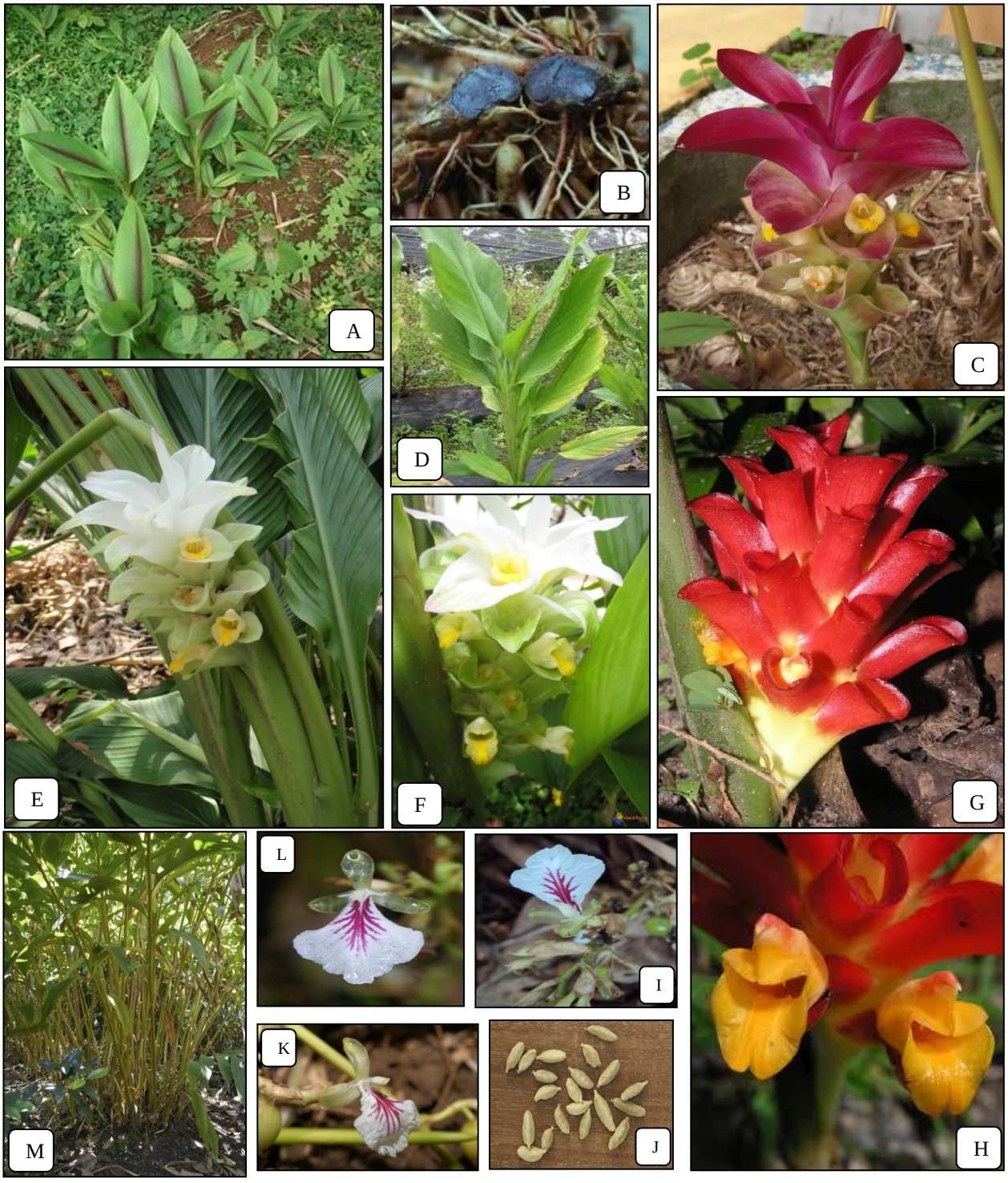
Amomum mizoramense : **A**-Habit, **B**-Ligule, **C**-Inflorescence, **D**-Rhizome with inflorescence, **E**-Bract, **F**-Bracteole, **G** & **H**-Flowers, **I**-Calyx, **J**-Corolla lobes, **K**-Stamen, **L**-Labellum, **M**-Stigma, **N**-Infructescence.

Photo Plate – V



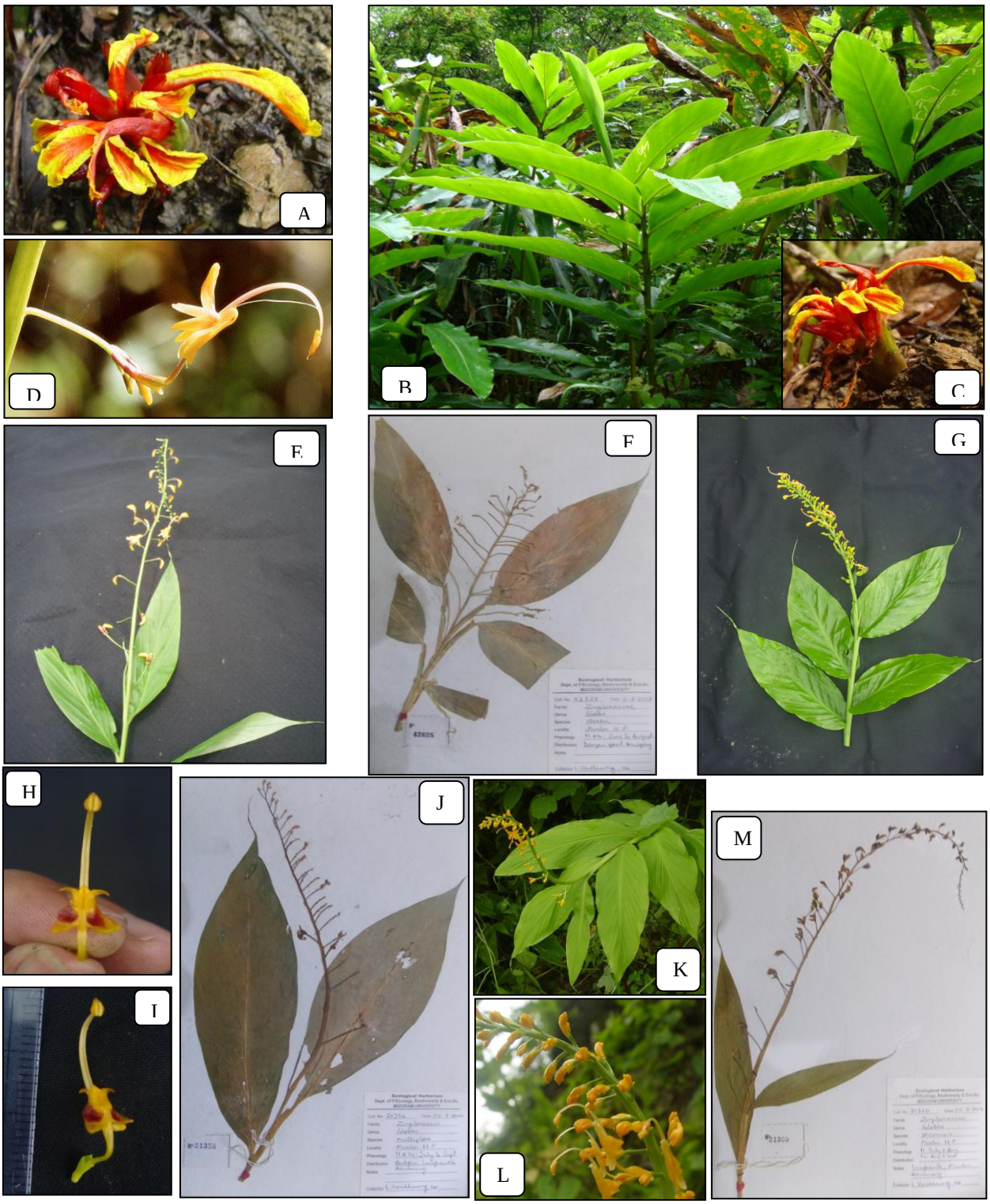
A	:	*Caulokaemferia linearis* (Flower).
B – C	:	*Cautleya gracilis* (B-Inflorescence & C-Habitat).
D - F	:	*Curcuma amada* (D-Rhizome, E-Habit & F-Inflorescence).
G - H	:	*Curcuma aeruginosa* (G-Rhizome & H-Inflorescence with habitat).
I - J	:	*Curcuma aromatic* (I-Inflorescence & J-Habit).

Photo Plate – VI



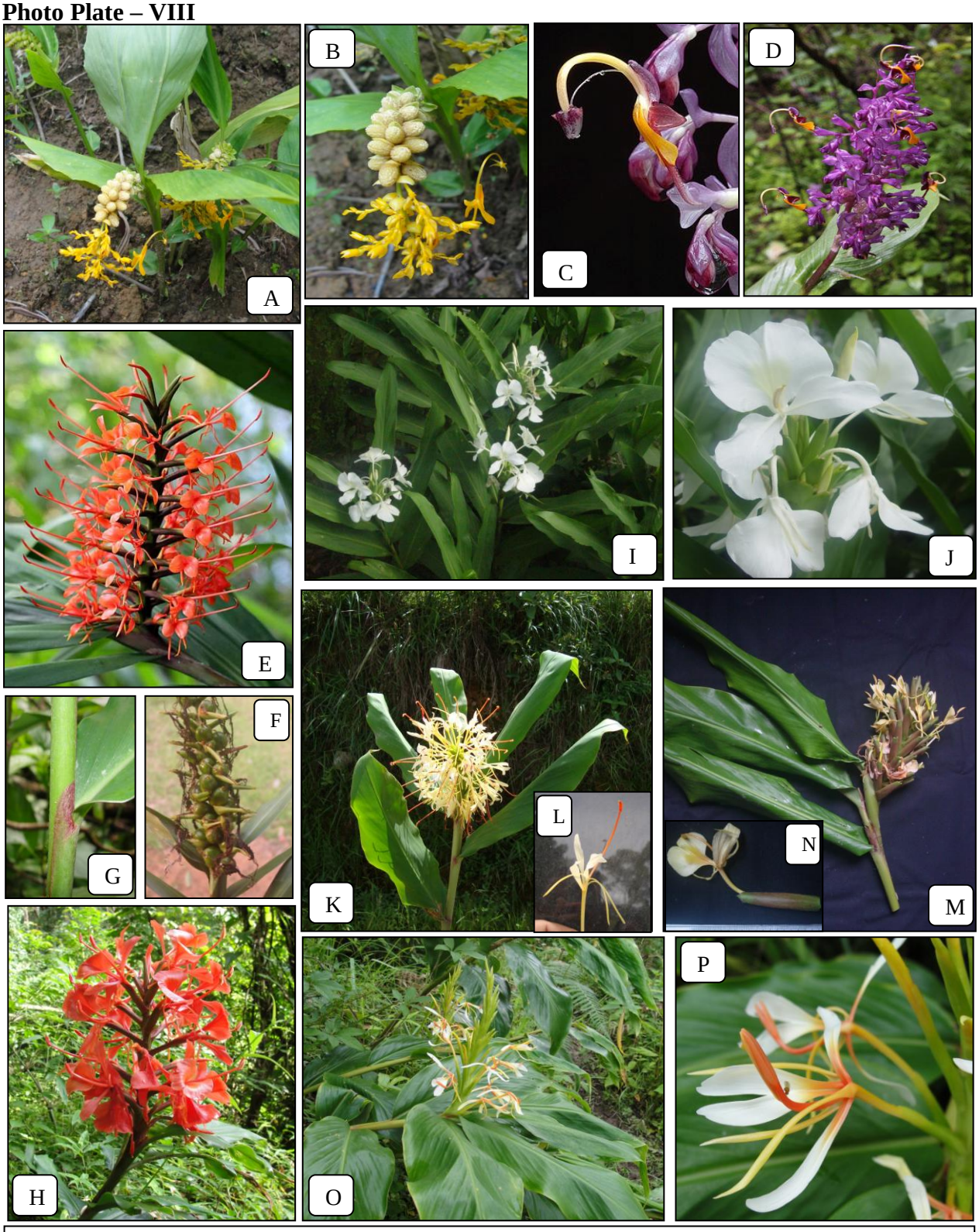
A - C :	*Curcuma caesia* (A-Habitat, B-Rhizome & C-Inflorescence).
D - F :	*Curcuma longa* (D-Habit, E-Inflorescence & F-Flower).
G - H :	*Curcuma rubrobracteata* (G-Inflorescence & H-Flower).
I - M :	*Elettaria cardamomum* (I-Flower with fruits, J-Seeds, K&L-Flowers and M-Habitat).

Photo Plate – VII



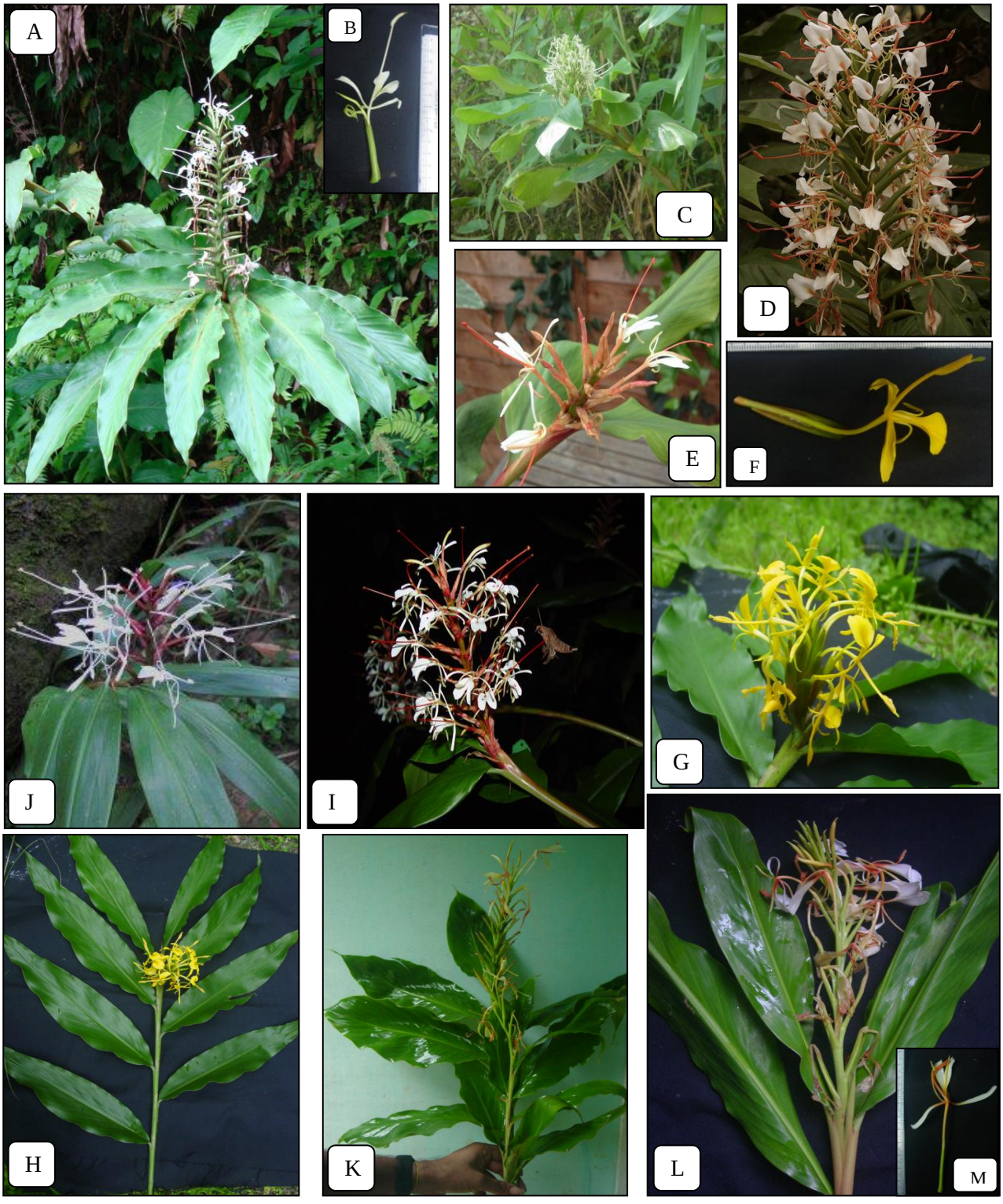
A - C :	*Etlingera linguiformis* (A&C-Inflorescence & B-Habit).
D - F :	*Globba clarkei* (D-Flower, E-Inflorescence & F-Herberium specimen).
G - J :	*Globba multiflora* (G- Inflorescence, H&I-Flowers & J-Herbarium specimen).
K - M:	*Globba orixensis* (K-Inflorescence, L-Flower & M-Herbarium specimen).

Photo Plate – VIII



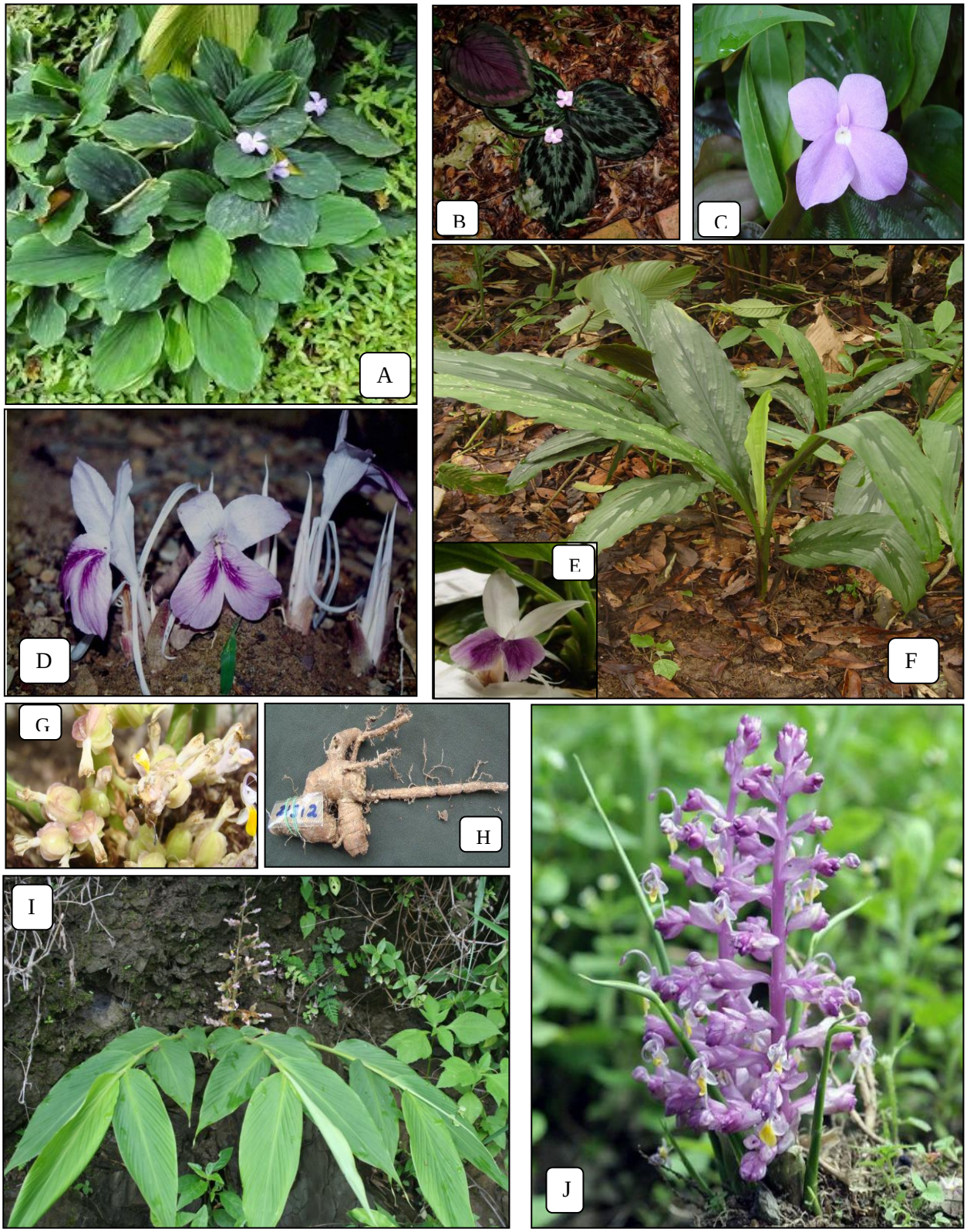
A - B : *Globba schomburgkii* (A-Habit & B-Inflorescence).
C - D : *Globba wardii* (C-Flower & D-Inflorescence).
E - F : *Hedychium coccineum* (E-Inflorescence & F-Fruit).
G - H : *Hedychium rubrum* (G-Ligule & H-Inflorescence).
I - J : *Hedychium coronarium* (I-Habit & J-Flowers).
K - L : *Hedychium ellipticum* (K-Habit & L-Flower).
M - N : *Hedychium flavescens* (M-Inflorescence and leaves & N-Flower).
O - P : *Hedychium spicatum* (O-Habit & P-Flowers).

Photo Plate – IX



A - B : *Hedychium stenopetalum* (A-Habit & B-Flower).
C : *Hedychium thyrsiforme* (Habit).
D - E : *Hedychium villosum* (Inflorescence).
F - H : *Hedychium wardii* (F-Flower, G-Inflorescence & H- Whole plant).
I - J : *Hedychium villosum var. tenuiflorum* (I-Inflorescence & J-Habit).
K - M: *Hedychium yunnanense* (K&L- Inflorescence & M-Flower).

Photo Plate – X

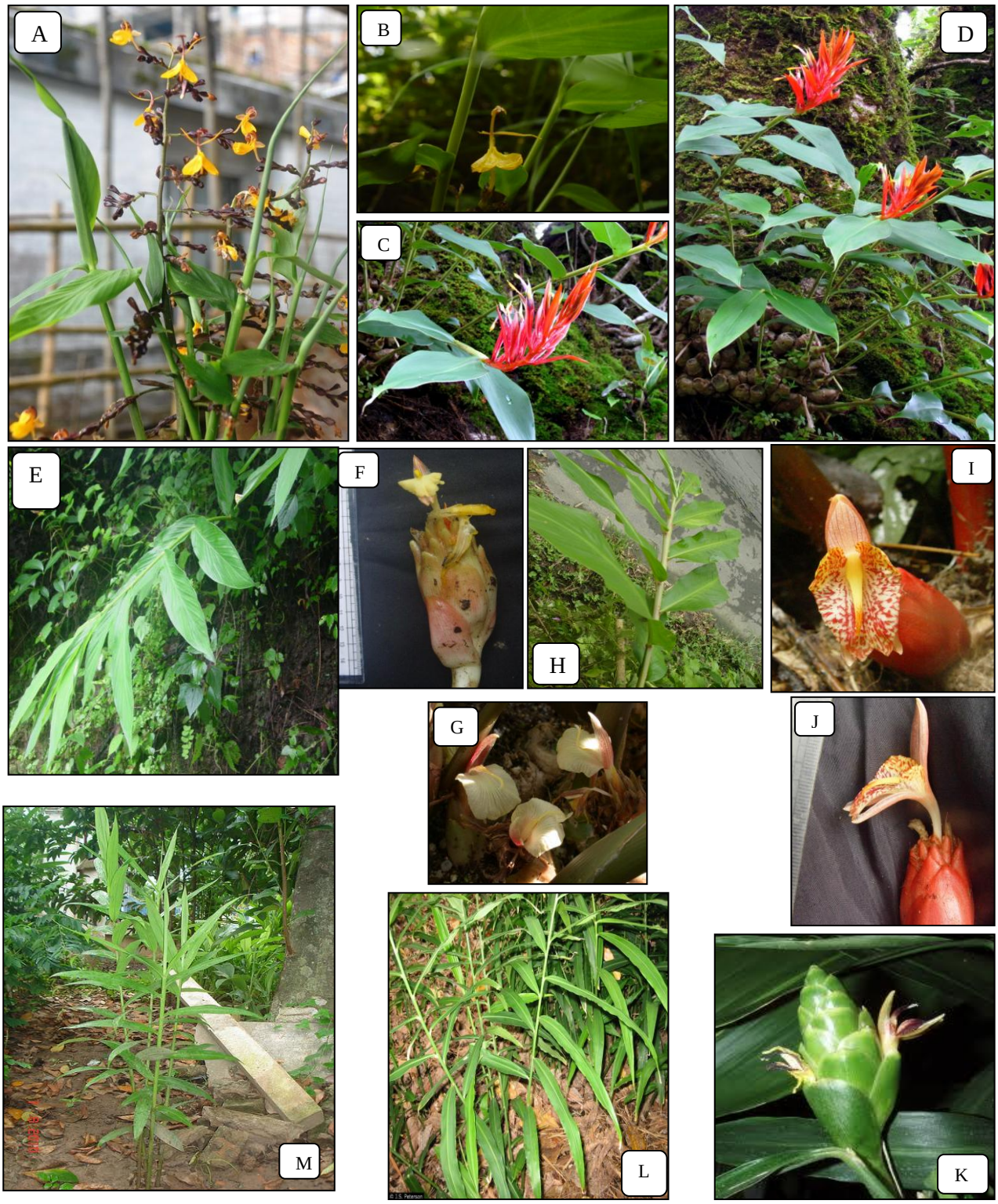


A - C : *Kaempferia pulchra* (A-Habitat, B-Habit & C-Flower).

D - F : *Kaempferia rotunda* (D-Inflorescence, E-Flower & F-Habitat).

G - J : *Mantisia spathulata* (G-Fruits, H-Rhizome, I-Habitat & J-Inflorescence).

Photo Plate – XI



A - B	:	*Mantisia wengeri* (A-Habitat & B-Flower).
C - D	:	*Rhynchanthus longiflorus* (C-Inflorescence & D-Habit).
E - G	:	*Zingiber ligulatum* (E-Habit, F- Inflorescence & G-Flowers).
H - J	:	*Zingiber rubens* (H-Habit and I & J-Inflorescence).
K - L	:	*Zingiber officinale* (K-Inflorescence & L-Habit).
M	:	*Zingiber purpureum* (Habit).